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## **Incorporation of Adaptive Management into Conservation Planning and Resource Management**

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### **Introduction**

The Mission of the California Department of Fish and Wildlife (CDFW) is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. Pursuant to Fish and Game Code section 703.3, resource management decisions of the CDFW should incorporate adaptive management to the extent possible. It is CDFW's intent to improve the management of biological resources over time by incorporating adaptive management principles and processes, as appropriate, into conservation planning and resource management. This includes:

- Designing monitoring and targeted studies that are integral to an adaptive management framework;
- Improving our organization's knowledge base by synthesizing new information gathered through monitoring, targeted studies, and credible scientific sources; and
- Regularly re-evaluating, based on the best available science, and adjusting if needed, our conservation and management strategies and practices to meet our long-term goals.

### Assembly Bill 2402 and the Science Institute

In September 2012, Governor Edmund G. Brown Jr. signed Assembly Bill 2402 (Stats. 2012, ch. 559, §§ 1-28) into law, which made a number of changes to Fish and Game Code. Among other provisions, the bill makes statements of policy relating to the use of ecosystem-based management, adaptive management, and credible science; and requires establishment of a Science Institute to assist CDFW and the Fish and Game Commission (Commission) in obtaining independent scientific review, advice, and recommendations to help inform their scientific work. Section 12 of the bill (refer to Fish and G. Code § 715, subd. (b)) states that the objectives of the Science Institute shall include, but not necessarily be limited to, the following:

1. Providing independent scientific guidance of the scientific research, monitoring, and assessment programs that support CDFW's and the Commission's work with fish and wildlife species and their habitats.
2. Providing the best available independent scientific information and advice to guide and inform CDFW and Commission decisions.
3. Promoting and facilitating independent scientific peer review.
4. Promoting science-based adaptive management.
5. Ensuring scientific integrity and transparency in decision-making.

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## Scope of this Document

This document was prepared by the Science Institute to provide information to CDFW's Divisions and Regions as they incorporate adaptive management in their conservation and resource management decisions and planning documents. It highlights statutory definitions, statements of policy and requirements that are relevant to CDFW's activities, and summarizes descriptions and evaluations of adaptive management in the technical literature.

This information is relevant to all CDFW activities involving the conservation and management of natural resources under the jurisdiction of CDFW. However, given the breadth of CDFW's Mission and the wide variety of regulatory, management and scientific roles CDFW plays, it should be emphasized that this information does not present a one-size-fits all approach to adaptive management. Rather, where adaptive management principles are appropriate and applicable in a given situation, the discussion and resources in this document should highlight issues for consideration under the specific circumstances at hand. CDFW affirms that project-specific circumstances always necessitate the development of project-specific adaptive management strategies. The information in this document is provided as a tool to be used, where appropriate, to support CDFW's Divisions and Regions as they implement the CDFW Mission. The general principles presented here are not intended to be relied upon absent, or in lieu of, site- or project-specific analysis that shapes the application of these principles.

Incorporation of adaptive management into more of CDFW's resource management and conservation decisions is consistent with:

- Fish and Game Code
- CDFW's 2006 Strategic Initiatives
  - Develop Statewide Land Stewardship (Initiative No. 2)
  - Expand Scientific Capacity (Initiative No. 7)
- CDFW's 2012 Strategic Vision
  - Highly Valued Programs and Quality Services: Practice Adaptive Management, and associated Science Recommendations (Goal 2, Objective 5)

## Definition

Adaptive management is defined under several sections of the Fish and Game Code and Water Code. These definitions are set out below.

- Fish and Game Code section 13.5 (General Definitions. Added by Assembly Bill 2402) – “Adaptive management,’ unless otherwise specified in this code, means management that improves the management of biological resources over time by using new information gathered through monitoring, evaluation, and other credible sources as they become available, and adjusts management strategies and practices to assist in meeting conservation and management goals. Under adaptive management, program actions are viewed as tools for learning to inform future actions.”

- Fish and Game Code section 90.1 (Marine Life Definitions) – “Adaptive management,’ in regard to a marine fishery, means a scientific policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning. Actions shall be designed so that even if they fail, they will provide useful information for future actions. Monitoring and evaluation shall be emphasized so that the interaction of different elements within the system can be better understood.”
- Fish and Game Code section 2852, subdivision (a) (Marine Life Protection Act – Definitions) – “Adaptive management,’ with regard to marine protected areas, means a management policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning. Actions shall be designed so that, even if they fail, they will provide useful information for future actions, and monitoring and evaluation shall be emphasized so that the interaction of different elements within marine systems may be better understood.”
- Fish and Game Code section 2805, subdivision (a) (NCCP Act – Definitions) – “Adaptive management’ means to use the results of new information gathered through the monitoring program of the plan and from other sources to adjust management strategies and practices to assist in providing for the conservation of covered species.”
- Water Code section 85052 (Sacramento-San Joaquin Delta Reform Act of 2009 – Definitions) – “Adaptive management’ means a framework and flexible decision making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives.”

### **Requirements Under Fish and Game Code**

The Natural Community Conservation Planning (NCCP) Act (Fish & G. Code § 2800 *et seq.*) mandates that all NCCPs integrate adaptive management strategies, in which the results of monitoring, research, and experimental habitat management feed back into decision-making, mediating uncertainty, and improving the effectiveness of NCCP implementation over time (Fish & G. Code § 2820, subd. (a)(2), (8)). NCCP documents must include a description of the plan’s comprehensive adaptive management and monitoring program(s). The Fish and Game Code also includes legislative declarations and requirements concerning the use of adaptive management in conjunction with activities under the Marine Life Protection Act (Fish & G. Code, §§ 2853 & 2856), the authorization of the taking of certain species in association with implementation of the Quantification Settlement Agreement (related to overall quantification, settlement, and transfer of various Colorado River water rights) (Fish & G. Code, § 2081.7), and trout management (Fish and G. Code, §§ 1726.1, 1728 & 1729). In addition, following the enactment of Assembly Bill 2402, the Fish and Game Code includes the following provisions relevant to the conduct of adaptive management.

- Fish and Game Code section 33 (Credible Science Defined) – “Credible science’ means the best available scientific information that is not overly prescriptive due to the dynamic nature of science, and includes the evaluation principles of relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of information as appropriate. Credible science also recognizes the need for adaptive management, as defined in section 13.5, as scientific knowledge evolves.”
- Fish and Game Code section 43 (Ecosystem-Based Management) – “Ecosystem-based management’ means an environmental management approach relying on credible science, as defined in Section 33, that recognizes the full array of interactions within an ecosystem, including humans, rather than considering single issues, species, or ecosystem services in isolation.”
- Fish and Game Code section 703.3 (Ecosystem-Based Management – Use Required in All Resource Management Decisions) – “It is the policy of the state that the department and commission use ecosystem-based management informed by credible science in all resource management decisions to the extent feasible. It is further the policy of the state that scientific professionals at the department and commission, and all resource management decisions of the department and commission, be governed by a scientific quality assurance and integrity policy, and follow well-established standard protocols of the scientific profession, including, but not limited to, the use of peer review, publication, and science review panels where appropriate. Resource management decisions of the department and commission should also incorporate adaptive management to the extent possible.”

### **Requirements Under Water Code**

The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) established as overarching state policy the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem (Pub. Resources Code, § 29702). The Delta Reform Act requires the Delta Stewardship Council to create and adopt a comprehensive and legally-enforceable management plan for the Delta (Delta Plan) to further the coequal goals (Water Code, § 85300). Water Code section 85308, subdivision (f) states the Delta Plan must include “a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions.” In addition, the Delta Plan must be based on and implemented using best available science (Water Code, § 85302, subd. (g)). The Delta Plan (Policy G P1, Delta Stewardship Council 2013) and its supporting regulations (California Code of Regulations, Title 23. Waters, § 5002) require the use of the best available science and incorporation of adaptive management into ecosystem restoration and water management programs, plans, or projects that are subject to the Delta Plan and regulations. This requirement is satisfied through both of the following: (1) the adaptive management plan for the project must use an approach consistent with the adaptive management framework described in the Delta Plan, and (2) the program, plan or project must document that there is access to adequate resources to implement the adaptive management process and delineated authority by the entity responsible for implementing the process.

## Principles and Processes of Adaptive Management

A rich literature regarding the theory and conduct of adaptive management exists and supports principles and processes discussed in the reference documents identified below. While differences among the various frameworks exist, they generally contain three broad phases: *Plan*, *Do*, and *Evaluate and Respond* (Figure 1, Delta Stewardship Council 2013). Figure 1 provides a representative example of the adaptive management process, including the three broad phases and the individual steps within the process.

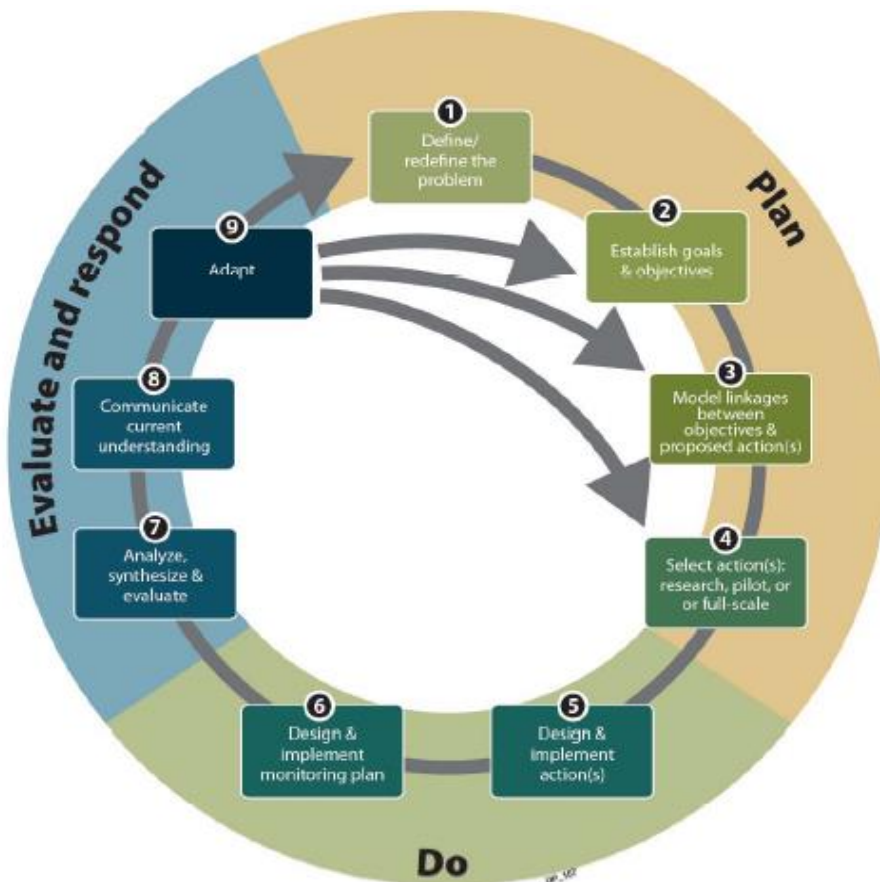


Figure 1: A Three Phase (Nine-step) Adaptive Management Framework. Source: Delta Plan (Delta Stewardship Council 2013).

Adaptive management has become a well-established principle and process within the resource management community. An adaptive management approach provides a structured process that allows for taking action under uncertain conditions based on the best available science, and re-evaluating and adjusting decisions as more information is acquired. The structured decision-making process used in adaptive management, involving articulation of objectives, identification of management alternatives, predictions of management consequences, recognition of key uncertainties, and monitoring and evaluating outcomes, is what differentiates it from a trial and error approach (i.e., try something, and if it doesn't work try something else) (National Research Council 2004, Williams 2011). However, despite its intuitive appeal, the application of adaptive

management has been less successful than one would expect (Gregory et al. 2006, Walters 2007, Allen and Gunderson 2011). Additionally, not all resource management decisions warrant the use of adaptive management (discussed further below). Implementation of adaptive management can be time-consuming and costly, but when it is appropriate and effectively applied, it has the potential to reduce uncertainty associated with management actions, provide long-term cost savings, and improve conservation and management effectiveness (Williams et al. 2009). The use of adaptive management for managing declining species may be particularly appropriate as adaptive management explicitly acknowledges and attempts to address the uncertainty inherent in managing species where basic biological information and an understanding of appropriate management strategies is often lacking (Fontaine 2011).

### Reference Documents

The following represents a brief list of current, readily available reference documents concerning the theory and practice of adaptive management. These documents should not be interpreted as an official CDFW directive, but rather as a source of information when considering the application of adaptive management in a particular circumstance. A partial bibliography on adaptive management is provided in Appendix A as an additional resource.

- Atkinson et al. 2004. Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans. U.S. Geological Survey Technical Report. USGS Western Ecological Research Center, Sacramento, CA. Available: <http://www.werc.usgs.gov/ProductDetails.aspx?ID=3005>.
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## Challenges and Lessons Learned

In most natural resource use programs managed by CDFW, informal adaptive management has been used for decades. These programs typically consist of management decisions (e.g., harvest level recommendations) embedded in management plans that include species population objectives. These programs are supported by long-running population monitoring programs that are used to assess the results of previous management decisions and inform future management decisions.

Another well-established CDFW program that relies on adaptive management is the California NCCP Program. Effective conservation through regional habitat conservation plans, such as NCCPs, depends on their ability to confront the challenges of adaptively managing and monitoring complex ecosystems. Assessments of such plans indicate that adaptive management should include opportunistic learning, hypothesis testing, management, monitoring, and directing the results of analysis and assessment back into the program through decision makers (see Atkinson et al. 2004, page 6, for a schematic NCCP/Habitat Conservation Plan adaptive management feedback loop). The adaptive management framework implies an ongoing scientific commitment to the NCCP in perpetuity (Noss et al. 1997). This requires an institutional structure and process that remains flexible and is committed to scientific rigor and quality results (Atkinson et al. 2004).

The practice of building effective adaptive management programs for large-scale multi-species NCCPs is an endeavor that continues to evolve. However, NCCPs in California are making real progress in designing adaptive management programs that work. For example, implementing partners of the San Diego Multiple Species Conservation Program (MSCP)<sup>2</sup> have demonstrated leadership in scientific collaborations and ecological applications that are informing strategic approaches to reserve management, monitoring, and habitat connectivity enhancement.

CDFW's State Wildlife Action Plan (Bunn et al. 2005) dedicates a chapter to monitoring and adaptive management. The chapter acknowledges that data used to support the iterative process inherent in adaptive management comes from monitoring the effectiveness of conservation actions directed at species and natural systems. Therefore, monitoring which measures ecosystem condition and response of the ecosystem to both intentional (management actions) and natural perturbations is a critical piece of the adaptive management feedback loop (Bunn et al. 2005). The steps for creating functional and scientifically defensible monitoring and adaptive management programs (Atkinson et al. 2004), as conceptualized in the 2005 State Wildlife Action Plan, are now being applied to conservation strategies under development for the State Wildlife Action Plan 2015 Update.

### **Identifying When Adaptive Management Should Be Used**

As identified above, certain CDFW activities are mandated by Fish and Game Code to include an adaptive management program (e.g., Fish & G. Code, §§ 2820 & 2856). Fish and Game Code sections 33, 703.3, and 715 promote the use of adaptive management in resource

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<sup>2</sup> <http://www.sdmmp.com/Home.aspx>

management decisions, to the extent feasible, but do not further define those decisions or provide more specific guidance.

The adaptive management literature cautions that not all resource management decisions/actions are amenable to adaptive management (Gregory et al. 2006, Williams et al. 2009, Allen et al. 2011, Allen and Gunderson 2011, Williams 2011). For example, policy and technical documents prepared by the U.S. Department of Interior (DOI) state that for adaptive management to be operationally appropriate and effective, there must be a mandate to take action in the face of uncertainty, and there must be institutional capacity and commitment to undertake and sustain an adaptive program (Williams et al. 2009). If no decision is necessary, if there is little uncertainty about what management actions to take and what outcome to expect, or if management cannot be adjusted in response to what is learned, non-adaptive management approaches may be appropriate (Williams 2011).

The DOI technical guide (Williams et al. 2009) identifies several considerations for determining whether adaptive management represents an appropriate approach to decision-making.

Adaptive management is most applicable when:

- 1) A management decision, involving a choice between alternative actions, needs to be made.
- 2) Decision-making is confounded by uncertainty about potential management impacts<sup>3</sup>.
- 3) The institutional capacity and commitment to undertake and sustain an adaptive program exists. For example, there is institutional support, including adequate and sustainable funding, to implement a monitoring program of sufficient intensity and scope to detect changes in biological response to management actions and to measure progress towards achieving management objectives.
- 4) Stakeholders can be effectively engaged.
- 5) Clear, measureable, and agreed-upon conservation or management goals and objectives can be established.
- 6) Resource relationships and predicted management impacts, along with the associated uncertainties, can be explicitly represented in conceptual and/or quantitative models.
- 7) A monitoring program can be designed to reduce uncertainty and inform decision-making, and progress towards achieving the management objectives can be measured.

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<sup>3</sup> Types of uncertainty could include: significant biological uncertainty about the ecology of the target species (or habitats) at the present time and/or under changing ecological conditions, the efficacy of management techniques, or the potential effects of management activities on the target species or habitats.



- 8) Management actions can be adjusted in response to what has been learned (i.e., there are opportunities for iterative decision-making).
- 9) The entire process fits within the appropriate legal framework (i.e., can be conducted in full compliance with applicable laws, regulations, and authorities).

### **Implementation of Adaptive Management**

Increasing the use of adaptive management processes within CDFW will require a significant commitment to ensure that those charged with implementing adaptive management have the appropriate training, expertise, and resources (e.g., funding). A variety of technical resources are available (as an example, see *Reference Documents* and Appendix A) and can serve as a foundation upon which CDFW can build and maintain the necessary infrastructure to support implementation of adaptive management.

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