# Uncertainty in Biodiversity Planning: Lessons from the Bay Area

Marsh 1998 Presentation to the Bay Area Local Forum
California Biodiversity Council

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Regional planning for biodiversity is a good idea. It can focus human and financial resources on well-defined ways to manage the land for the life people want, or need. It might thusly improve government.

Here in the Bay Area, the regional community of environmental scientists and resource agencies has been working for about 5 years to recommend long-range ecological goals. I am one of the architects of the plan, and I have coordinated the scientific support.

From my perspective, regional planning for biodiversity boils down, or adds up, to an ongoing discussion of how much of what kinds of habitats are needed where, and why. The discussion will hopefully be moved along by on-the-ground projects to test ideas.

The practical steps in biodiversity planning have been stated by other people in other regions. Using the vernacular of the Bay Area, the steps are:

1. set shared numerical goals for habitats (how much of what kinds of habitats are needed where, and why);
2. adjust policies, programs, and projects as tools to achieve the goals (look within the region for the means to achieve the goals);
3. monitor progress toward the goals (and monitor the risk that the goals will not be achieved); and
4. adjust the goals for new understanding and changing expectations.

The first step is the most difficult. According to the Bay Area experience, shared goals are based upon three kinds of understanding, the past, the present, and change. A detailed picture of the past has been essential for understanding the present, and to forecast the future. The picture of the past shows what kinds habitats tend to evolve where, under natural controls of climate and topography. It is essential to understand the relative roles of human history and natural history in shaping the landscape.

Science is involved at every step to frame the possibilities and advance the public debate, in the context of what is known as scientific fact, what can be reasonably extrapolated from the facts, and what might be guessed, based upon experience. It is important to keep track of these different levels of certainty about the information that gets used.

I don't mean to suggest that scientists have all the answers, or all the questions. But biodiversity planning seems to hinge on scientific understanding.

There are risks in biodiversity planning. There is the risk that the plan will fail. The risk of failure is mainly a function of environmental variability, and of uncertain or volatile attitudes. I would like us to look more closely at these interrelated sources of risk.

## How to minimize the risk of uncertain attitudes

The success of regional plans for biodiversity depends upon an operational definition of ***biodiversity*** and ***region***.

We will need to face some complicated questions to operationalize the concept of biodiversity. But if we do not operationalize this concept, then we will not be able to set or achieve biodiversity goals.

Let me ask a few basic questions about biodiversity that I think should be answered, and that have not yet been clearly answered by the Biodiversity Council. We might be able to answer these questions for ourselves, within the region called the Bay Area. I will suggest some starting answers.

Q. Which of the various definitions of biodiversity should we adopt? Some of the definitions listed by the Council embrace or include introduced species, and others do not.

A. We may lament the displacement of "native species" by "introduced species," but would we now want to rid ourselves of the urban forests that support song birds, just because the forest consists of "introduced" trees that displaced "native" coastal prairie? I think the answer is a limited yes - yes only if and where the urban forest interferes with out efforts to recover and manage the prairie. And we might worry about how our efforts to mange our ecosystems for one set of species over another will open the door for more species introductions, or what connotations we impose upon inner-city people living amidst so many introduced “bad” species.

My point is that ecosystems don’t care; (some) people do. Everything we do is land management, whether we plant a forest, cut it down, daylight a creek, or bury it, let loose the ballast water, or not. We are in charge, and we are faced with complex choices.

I suggest that we include all species in our scientific thinking about biodiversity, to minimize the amount of sentimental judgment in science.

Q. What ***is*** an introduced or non-native species?

A. Almost all of the plants and animals that now inhabit San Francisco Bay, and most of what inhabits the creeks, valleys and hillsides, have come here from somewhere else. The Estuary and its wetlands are very young, mostly less than 5,000 years old, and they have been subject to many local changes in community composition due to estuarine transgression punctuated by short term but rather extreme climatic shifts. The species-area curves for bays, wetlands, and watersheds are dominated by species that are not ancient members of our communities. For the sake of discussion, we might assume that an introduced species is one that has come here through the actions of people. I think this means that people are an introduced species. So are the species that people have brought here with them, such as California Walnut, Striped Bass, and Starlings.

Q. What determines if a species is good or bad?

A. There is a sentiment that introduced species are bad. This sentiment is pervasive among some environmental interest groups. And it is espoused by some scientists. It seems to me that the decisions about good and bad are a matter of society and management, not science. My experience suggests that an “introduced species” or even a “native species” might be regarded as “bad” if it increases the risk of failure to manage our ecosystems for desired ecological services. The native Poison Oak may be bad for camping. East Coast Cordgrass may be bad if it covers tidal mudflats and thus interferes with shorebird management.

***The first step to reduce the risk of failure due to uncertain attitudes is to separate the technical or scientific aspects of biodiversity from the aspects that are more social, almost sentimental. I suggest that "biodiversity" can be a strictly scientific term, but other terms like "bad" or "good" species, and perhaps also "introduced" and "native" species cannot be strictly scientific.***

Now let's turn to the problem of region, or geographic scope. The plan must be practical. And we talk about regional planning.

Q. What ***is*** a region?

A. The most practical regions define themselves, in terms of climate, landscape, and sociology. They minimize the externalities for ecological services within the region.

A practical region is small enough that regional leaders know each other well, a consensus of understanding can be achieved, regional decisions can be visualized as local changes, and almost everyone gets all the information that they need. It is certainly possible to make a region too big.

The distributions of newspapers, the geography of issues, the boundaries of watersheds, the lines of local jurisdiction, all help to define practical regions.

We might note that the average patch sizes of soil types, ecotypes, and microclimates is smaller than any region that accounts for the way people think about each other and the land. It is certainly possible to make a region too small.

In an urbanized region like the Bay Area, biodiversity plans will be implemented by local agencies. The Clean Water Act and the Endangered Species Act meet the ground through cities, counties, and special districts. Ecological planning must therefore integrate vertically through government, from cities to federal agencies, and it must integrate horizontally through the sectors of society. Otherwise, regional planning is simply an exercise among the planners.

> Based upon these considerations, the bioregions of the Biodiversity Council are probably not practical, at least from the local perspective. They are simply too large for local interests to see themselves as operational parts of the region. This increases the need for centralized, top-down control, which increases local uncertainty about the motives and efficacy of the regional plan, which increases the risk of its failure.

***The second step to minimize the management risks of uncertain attitudes is to focus on regions that encompass a strong sense of place and ecological belonging that is shared among cultures within the region.***

## How to Minimize the Risk of Natural Variability

We cannot ignore or control the variability of climate and landscape. There is no such thing as earthquake control, or hurricane control. And there is no such thing as landslide control, or flood control. What we can do is manage the risk associated with climate change and landscape change.

In the Bay Area, rain is maybe twice as likely north of Alcatraz. Five consecutive days of winter storms will produce twice as much rain in Napa than in San Jose. And within a subregion, such as the North Bay, drought, deluge, and significant differences among winter storms punctuate the record of rain.

Our landscapes are active. Landslides and fault zones are never very far away. But the risks of landslides and earthquakes are greater in some places than others. There are places where smaller landslides occur inside the boundaries of larger landslides that occur inside fault zones. And people and other species, native and not, are living in some of those placers.

The variability of climate and landscape accounts for most of the “natural” biodiversity in the Bay Area. Biodiversity planning should accommodate the natural variability of the environment. For example, terrestrial habitats should be large enough to accommodate fire. Wetlands and aquatic habitats should be large enough to accommodate changes in water and sediment supplies.

And I doubt that we can prevent species invasion or colonization, natural or not. I doubt we want to prevent the free movement of all species. As sea level naturally rises, our native cordgrass that inhabits salt marshes is moving upstream into places it has never occupied. That is natural and probably acceptable to most managers. Or is it?

***There are two main ways to minimize the land management risk due to natural environmental variability: (1) choose ranges of conditions for management goals that reflect the natural variability; and (2) defer as much as possible to natural processes for land maintenance.***

**How to Minimize the Risk of Unnatural Variability**

The uncertainty of climate and landscape is often ***increased*** by human operations. For example, in Bay Area watersheds, land management practices in headwater areas increase the runoff that causes erosion of channel beds and banks. The increase in runoff from urbanized slopes helps transport the sediment downstream to the flatlands, where tidal marsh reclamation and undersized bridges reduce the channel capacity. Here the sediment accumulates, raising the channel bed and greatly increasing the risk of flooding.

The uncertainty of climate and landscape can also be ***decreased*** by human operations. Dams and other impoundments can reduce the variability of streamflow. Weirs and gates damp the tides in diked baylands. The result is local reductions in plant species diversity. Fire, natural or jot, levels the age distribution of chaparral.

As I mentioned before, the Estuary is young and subject to frequent natural disturbance that increases the risk of species invasions. And the combined variability of climate and landscape and human operations has increased the rate of species introductions. Most species that inhabit the Bay Area came from somewhere else. The urban forests on local hillsides and alluvial plains add structure as well as tree species, insect species, and bird species. Rotational landslides caused by urban runoff form small wetlands as the base of landslide scarps. Amphibians live in these little wetlands, The reclamation of tidal marshlands adds habitats, like salt ponds, that add bird species to the regional community. In the Bay Area, the rate of species introductions far exceeds the rate of extinction or expurgation.

There is ecological theory and observations supporting the general idea that disturbance through space and over time increases species richness. Richness may be greatest at intermediate levels of disturbance.

The environmental variability due to land use and management has decreased the overall certainty of management success, while increasing overall biodiversity, in terms of *total* species richness and ecosystem structure.

Here is the central conflict. Biodiversity, in its largest meaning, is positively related to environmental variability through space and over time, at least up to some theoretical maximum limit of disturbance. But the variability also increases the uncertainty of management, and we need to manage the land for selected ecological services. We are not living in wilderness; we seek food, shelter, and recreation in forms that require management of our ecosystems.

And here is a major complication. Climatic changes, whether natural or unnatural, affect regional environmental variability. Over the past 20 centuries, our Bay has increased and decreased in salinity due to changes in runoff caused by climate change beyond our regional control. We need only remind ourselves of accelerated sea level rise due to global warming to realize that we cannot completely manage our situation. For example, our regional efforts to restore tidal wetlands may be thwarted by rapid sea level rise.

But, within the context of things we can't control, we can maximize our chances of successful ecosystem management by not fighting against natural processes endemic to our region and its locales. Land management practices that oppose natural variability increase the overall environmental variability and thus increase the risk of management failure.

***There is only one pathway to minimize the management risks due to unnatural environmental variability. It's been said before: plan and manage with nature. We can decide how much of what kinds of services we want where, in the context of their natural variability, and then we***

***can get out of the way of the natural processes that maintain the selected services. Or, we will fail expensively.***