8 Evolutionary and Cyclical Change as Fundamental Attributes of the Estuary
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Introduction

The two decades of literature in landscape evaluation have focused more on the static than on the dynamic. While this preoccupation with current form was necessary to establish basic principles, a means must now be found for incorporating short- and long-term change into the philosophy and method of visual analysis. This chapter looks at the visual-cultural attributes of (1) the morphologic evolution and (2) the tidal cycles of estuaries. Both forms of landscape change are considered to be intrinsic characteristics of the resource, although emphasis is placed on evolution.

The Philosophy of Change as Meaning

Meaning is the ultimate phenomenon we seek to grasp in landscape evaluation, whether we are landscape manager or casual viewer. Certain categories of meaning take higher priority in our minds than others. The concept of change and all that is means is commonly applied to what we sense. We are unlikely to ask consciously about landscape change as we move about our daily routine. Yet when we look at a wetland and consider it as a significant part of our environment, we are capable of inquiring about its past and future states.

If, as Suzanne Langer says, the landscape operates as a language to convey meaning, we can think of visual analysis as having advanced to the point of identifying the important elements of vocabulary and syntax. What remains is to find ways of employing these static elements in a dynamic grammar that communicates richer and more complete landscape meanings. We know that a snapshot of another person is an incomplete picture of that person. It is easy to think beyond that image and see the person as having evolved from youth, of having a future morphologic state, and of having the ability to move about in his or her current morphologic state. We have acquired the information necessary to envisage the total image of another person from our own experience and from learned concepts of human maturation.
and development. However, the important concepts of wetland dynamics and maturation are only recently being made available to us.

The "uninformed" viewer of wetlands will be content to look for a pleasing texture and assemblage of color and perhaps a similarity to known landscapes: a lake or a field of wheat. Others will seek meaning about the scene from an explanation that may have been suggested to them. Thus, our task is to organize visual information about wetlands to convey an understanding of change.

**Cyclical Change**

Most landscapes undergo some form of cyclical change: That is, the viewer is aware of repetitive transformations in the set of visual attributes. If we think of the deciduous forest landscapes of the Adirondacks, the Rocky Mountains, or the Midwest, the sequence is predictable and cyclical. The estuary landscape is dominated by the tides. They undergo visual (and functional) change daily, monthly, and seasonally. These cyclical events are linked with the directional process of succession and evolution because tidal action determines how sediment erosion, transport, and deposition will combine with marsh invasion to transform the estuary slowly into a coastal meadow.

**Wetland Evolution**

Wetlands have been called the ephemeral landscape. While there are certain wetland forms that are relatively stable, we must assume that change is a fundamental characteristic of most wetland types.

Until fifteen years ago wetlands were a neglected and unappreciated landscape, being neither sound land nor good water. Then, in a wave of concern over their imminent loss, the public began to appreciate the attributes of marshes, bogs, swamps, and estuaries.

Not only succession but also the rate at which estuaries were evolving inspired a concern for preservation. This concern stemmed at first from the evidence that humans had transformed, through dredge and fill, much of our national estuarine resource into sound land and good water. The subsequent realization that Nature was at work, too, led to the conclusion that—in contrast to forest succession where the end product is still forest—the terminal condition for estuarine evolution was extinction of the resource and creation of a new landscape, the coastal meadow.

It was argued that some estuaries were "in their last stages of maturity" and others were "suffering from senescence," soon to be lost to the next successional state. The political dimensions of this controversy often centered on the question of whether to preserve the natural process of succession or to manipulate the hydrology of an estuary to arrest succession and preserve the wetland landscape.

**Human Influence on Change**

If we accept the premise that the human influence on nature and the visible changes it brings about is easily comprehended by most people, how in confronting the dynamics of an estuarine landscape can the visual analyst include in his or her interpretation an understanding of this dimension? Human influence of course is not to be thought of in only negative terms. A viewer of landscape often relates more easily to the human imprint, the artifacts of his species, than to the natural. Nature, to some, is alien. A touch of humanity provides a point of reference, especially if there are hints of antiquity and the raw edges of human action have been visibly worn by time. Insofar as we look to the landscape for meanings about our identity, relations among people, and, for some observers, relations between people and their dieties, we must assume that any landscape view is a medium for understanding the theater of life.*

We will consider human influence on the dynamics of the estuary primarily in terms of

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*Glacken (1967) argues that human modification of the natural environment is one of the great themes of Western civilization. He bases his argument on an analysis of the literature, but others agree that, along with time and space, negotiations "conquest" is too simple, and it often exaggerates the relationship with nature is a fundamental dimension of human life and not just a preoccupation of the literati.
succession. While tidal dynamics constitute an important visual consideration, human influences on cyclical change are of secondary importance. The types of human influence on successional change to be discussed are those activities that increase or decrease (1) the deposition rate and/or (2) the rate of plant invasion and development in the estuary.

The following section elaborates on the concept of estuarine evolution and describes the principal morphologic units of an estuary with an eye to how they typically change over time. The third section explains how to document estuarine evolution. The fourth section discusses how the visual characteristics of an estuary change during the tidal cycle. The fifth and sixth sections deal with the geographic and political contexts for interpreting cyclical and evolutionary change.

The Morphologic Evolution of Estuaries

The life cycle of an estuary begins when a coastal valley is flooded by coastal subsidence or rising sea levels. Its ontogeny is complete when under stable sea-level conditions the embayment is completely filled with sediment and invasion of terrestrial (nonwetland) vegetation creates a coastal meadow. Sea levels began their rise at the end of the last glaciation some ten to fifteen thousand years ago. Until about two to three thousand years ago, when sea levels began to stabilize, deposition rates in coastal embayments were seldom greater than the rate of sea-level rise. Only during the more recent period when sea levels became relatively stable did estuaries become "wetland landscapes" with elements of marsh, mudflat, and channel.

During the period of human habitation of the watersheds and littoral zones of the world's estuaries, sedimentation rates have increased, partly because of land use. In general, with sea levels remaining roughly what they are today, many estuaries and lagoons will enter the last phases of their lives within the next fifty to one hundred years. In some cases the speed with which they grow old will be influenced by humans: in some cases increased, in others decreased.

During the life cycle the most visible changes will be the creation of extensive mudflats, the constriction of channels, and the expansion of marsh, finally spilling into the channels to clog this circulatory system with vegetation. The direct visual consequences of morphologic change will be the changes in the relative extent of the three morphologic units: marsh, mudflat, and channels. Indirect consequences will follow. Changes in speciation and frequency of visible biota, primarily birdlife, will result from changes in the lower strata of their food chain (i.e., speciation and frequency of organisms inhabiting each morphologic unit).

Approaches to Describing Estuarine Evolution

The terms used in this chapter need some refinement. The classical notion of "succession" implies changes in plant and animal communities: changes in the presence and dominance of species and changes in production at various trophic levels. For some, succession implies an end state or "climax" that involves stabilization of the species mix and system equilibrium. Succession has been applied to generalized modes of wetland evolution in introductory texts in physical geography and ecology. The common example shown in Figure 8.1 employs morphologic units of vegetation and describes evolution using a sequence of profiles with some attention to the stratification of peat soils. Beyond this, there is no discussion of trophic changes or shifts in diversity and speciation at various stages in the successional sequence. It would seem obvious that wetland succession does not stabilize at a terminal climax but continues through the transition into a terrestrial sequence of succession. At the beginning of the terrestrial sequence, the wetland as a landscape entity becomes extinct.

More appropriate to the topic is Redfield's (1972) portrayal of the development of Barnstable Marsh in Massachusetts. For the period 1300 B.C. to A.D. 1950 Redfield employs a sequence of maps that shows changes in four morphologic units: upland, sand dunes, intertidal marsh, and high marsh (Figure 8.2). If the visual analyst and land manager are to characterize the evolution of an estuary, the selection of morphologic units must be based only on intrinsic wetland attributes. Thus the method presented in this chapter varies from Redfield's ap-
Figure 8.3. Morphologic units of an estuary as principal visual components. (1) Intertidal marsh, extending from right margin of photograph; (2) mudflats, a rich substrate for feeding shore birds; and (3) channels full of water, even at low tide.

proach by eliminating upland and sand dunes because they are elements of the terrestrial landscape and generally lie above the traditional boundaries of the estuary, mean high water. Furthermore, no distinction is made between high marsh and intertidal marsh. In California, where I did my field studies, the high-marsh community of Distichlis spicata (saltgrass) was more often than not of relatively minor areal extent, in contrast to the large fields of saltgrass contiguous to eastern estuaries. Also, historical references rarely distinguished between high and intertidal marshes, making it difficult or impossible to reconstruct the evolution of an estuary employing that boundary. Finally, two additional morphologic units have been added—mudflats and channels—to those used by Redfield to allow for a more comprehensive treatment of estuarine evolution.

The Principal Morphologic Units of an Estuary

I have divided the estuary into three morphologic units: (1) the intertidal marsh, (2) the mudflat, and (3) the channel (Figure 8.3). These compose the gross visual structure under either static or dynamic conditions and are valid units for both visual analysis and ecological function. Thus in this classification are the principal components that compose the food chain and act together to engineer estuarine succession. This congruence of apparent visual attributes with ecologic attributes qualifies the estuary as a landscape potent for interpretation and meaning.

The Intertidal Marsh: From the line of mean high water (MHW: on the Pacific Coast, mean higher of high water, or MHHW) down to the lower edge of the intertidal vegetation, several plant communities exist in zones determined mostly by elevation and tidal submergence. The upper boundary between intertidal marsh and the adjacent terrestrial vegetation is not well delineated; often it shows a "diffuse" edge. (The visual terminology is from Litton et al., 1974). Within the marsh the boundaries between communities are either "digitate" or "butts." These fairly clear lines of demarcation result from dif-
ferences in the physiology of the dominant species, especially with respect to salt tolerance and the ability to withstand submergence.

One of the most important visual considerations in the marsh component of estuaries is the distinction between those estuaries with a predominately Salicornia marsh as opposed to those with a Spartina marsh. In many of the world's estuaries the marsh is dominated by the low-growing pickleweed, Salicornia, which forms a bumpy cover. In a Spartina marsh fields of tall cordgrass undulate in the shore breeze in an entirely different visual display (Figure 8.4).

The Mudflats: The unvegetated zone lying between the marsh and the channel is the mudflat or tidal flat. At first encounter, this zone seems visually barren. Yet much of the estuary action takes place here. Loaded with benthic organisms, the mudflat is an important feeding ground for shorebirds. They take worms and ghost shrimp from the mud as the tide goes out and cull young fish from the first incoming waters of the flood tide. In addition, this is the zone of active marsh invasion, where fingers of vegetation reach out to claim the rich substrate.

The Channels: The remaining portion of the estuary below the mean low water line (MLW: on the Pacific Coast, mean lower of low water, or MLLW) can be termed "channel." Even at low tide these winding incisions in the estuary bottom are full of water. A complex of tributary channels, lying technically above the MLW elevation, together with the main channels, constitutes the estuary's circulatory system. The complete network forms a sinuous branching pattern that is one of the estuary's more predominant visual characteristics. While some of the channels may shift their location from year to year, the pattern is essentially permanent, given repeated visual emphasis by the galleria of shorebirds waiting along the channel banks at each incoming tide.

Ulrich (1976) asserts that observers prefer those landscapes that display "ordered or patterned complexity" and show low preference for those that exhibit unordered or random complexity. The incised, branched network of estuarine channels is a familiar pattern in the environment of Homo sapiens, and it conforms to Ulrich's definition of ordered complexity. The tides flow through, visually unifying the principal components of the estuary.

A Method of Documenting Morphologic Evolution

The purpose of describing morphologic evolution for visual assessment is to provide a picture of the areal extent of each of the three morphologic units—marsh, mudflat, and channel—at intervals during which there are adequate data. Most often these intervals are restricted to the tenure of human habitation or exploration. A picture of the historical evolution of an estuary provides a basis for making estimates of how the morphology will change, and at what rate, under different future conditions. The first step is to characterize the estuary's present morphologic status.

Delineating Current Morphologic Status

The work cannot proceed easily without a set of aerial photographs taken at the scale and resolution determined by the analyst to be appropriate to the morphologic complexity of the estuary. The choice of black and white or color in any of the spectral classes is often determined by how well the photography allows one to separate (1) upper marsh from terrestrial vegetation, (2) lower marsh from mudflat, and (3) mudflat from water in the channels. Black-and-white infrared or color infrared provides good delineation in most estuaries. The investigator should be aware of the problem of algae deposition on the mudflats, which will give a reflectance somewhat similar to that given by lower marsh at small scales and low resolution.

The air photography should be taken at a time of year when vegetation reflectance signatures provide clear distinctions and at a time of the day when the tide is at MLW, the elevation at which channel units are distinguishable from mudflat. The best conditions, both in terms of plant color differences and atmospheric clarity, are often found in fall and spring along all three coasts of the United States.

If possible, an elevation and distance survey should be conducted to allow accurate calculations of areal extent of marsh, mudflat, and channel units. (Most estuaries are near survey benchmarks.) This is the only means of determining the line of MHW (MHHW) that serves as the boundary of the estuary. This boundary
Figure 8.4. Comparison of Spartina and Salicornia form. (Left) Wheatlike Spartina (cordgrass) occurs as tall, undulating fields (specimens of Spartina foliosa shown here are shorter than the aggressive Spartina alterniflora of the Atlantic and Pacific coasts), compared with (center) low, bunchy Salicornia (pickleweed) that produces dense mat. (Right) Field of Spartina foliosa (California), colonizing the mudflat abutting the channel, is one of the principal visual features of many estuaries.
sometimes coincides with a vegetational transition that can be seen on the air photographs, making the delineation fairly simple. In many estuaries the transition from high marsh to terrestrial vegetation occurs at an elevation above MHW.

The upper and lower elevations of each morphologic unit can be very useful to ecologic interpretations, which will add meaning to any understanding of cyclical or directional change. For example, elevations of the lowest marsh plants indicate the rate and form of mudflat conversion to marsh and how fast channel patterns are being stabilized by marsh vegetation. Elevations of this kind can be compared to those for other estuaries to suggest relative rates of marsh invasion and consequently to determine whether the estuary is changing morphologically more slowly or faster than others in the same geographic region.

As part of the survey, the general distribution of dominant marsh species should be noted. This will assist in estimating the rate and form of marsh invasion of mudflat units. For example, in many California estuaries Spartina foliosa (cordgrass) is a more active invader of the mudflat than Salicornia (pickleweed), the other common marsh plant. Each has its own pattern of invasion. However, Spartina is not present in all California estuaries, and it is absent from most estuaries in Oregon and Washington. Consequently, those estuaries with Spartina dominating the lower marsh will exhibit a different pattern and rate of morphologic evolution than those estuaries where Salicornia, exclusively, composes the marsh. Because both occur in nearly pure stands, noting their presence and location also helps in describing the static visual characteristics of the estuary. During tidal transformations estuaries dominated by either Spartina or Salicornia will look quite different from one another.

**Interpreting Historical Patterns of Change**

One can work backwards in time, seeking first the most recent historical map of the estuary, then uncovering earlier documentation. However, there is no reason why the investigator should not go directly to the first coastal survey. It is critical to remember that the information contained on any particular map will be related to the purpose of the map and mission of those doing the mapping and cartography. The following examples taken from Bolinas Lagoon in Marin County, California, will emphasize this point.

The first map (1897) constructed by the U.S. Geological Survey of Bolinas Lagoon and vicinity occurs as part of the Tamalpais Quadrangle (Figure 8.5). It would appear that the lagoon was in a "youthful" stage of its morphologic evolution, exhibiting no marsh and mudflat components. The picture conveyed by this map is one of a simple embayment with a bar and inlet. However, the mission of the USGS was to map terrestrial features, not wetland environments. The map is of no use for documenting morphologic change within the estuary. The first map of Bolinas Lagoon done by a legitimate agency capable of accurately documenting estuarine geography was constructed by the U.S. Surveyor General in 1858 to confirm the boundaries of the Baulinas Rancho land grant (Figure 8.6). In 1858 the government wanted to survey only lands above the approximate line of mean higher of high water and to delineate ground solid enough for grazing, agriculture, and the construction of rancho homes. There was no intention of including tidal land unsuitable for these purposes, and therefore it is not surprising that the map omits marshes, mudflats, deltas, and islands or a full rendering of the bar across the embayment.

In contrast to and predating these two maps, the first U.S. Coast Survey map of Bolinas Lagoon dated 1854 is an excellent base for reconstructing the estuary's morphology (Figure 8.7). To prepare a morphologic picture from this map, one must use Aaron Shalowitz's "Shore and sea boundaries, with special reference to the interpretation and use of Coast and Geodetic Survey data" (1964). The following sections should be noted: "Symbolization of Topographic Surveys" (pp. 188–92); "The Line of Mean High Water" (pp. 172–76); and "The Low Water Line" (pp. 183–89). The heavy solid line on the map represents the line of mean higher of high water, which is assumed for purposes of morphologic analysis to be the boundary of the estuary. Where marshes exist, the seaward edge of the marsh represents only the edge of the vegetation, as noted by the surveyor, and does not conform to a particular tidal plane. The in-
Figure 8.5. First U.S. Geological Survey map of Bolinas Lagoon vicinity, 1897. Note the absence of morphologic detail within the estuary.
Figure 8.6. First U.S. government map of Bolinas Lagoon vicinity, done by Surveyor General, 1858. Note the absence of morphologic detail in the estuary and token (erroneous) representation of the sandspit across the mouth of the lagoon.
Figure 8.7. First accurate survey of estuary conducted by U.S. Coast Survey, 1854. (Representation of marsh, mudflats, and channels provides a good picture of the lagoon's morphology.)
ner edge of the marsh, shown on the map, for
the most part corresponds to the line of mean
higher of high water. Where it was difficult for
the surveyor to discern the MHHW line of the
marsh, the inner edge will not conform pre-
cisely to that elevation.

The U.S. Coast Survey (later the U.S. Coast
and Geodetic Survey) completed two sets of
maps for most areas. They are denoted as either
"topographic" or "hydrographic" maps. The
topographic maps show marshes and lines of
MHW (MHHW), MLW (MLLW), with some up-
land vegetation and selected roads or buildings.
The hydrographic maps note the depths of
navigable water at spot locations using the
topographic map as a base. The hydrographic
map for Bolinas Lagoon (1854), a companion to
the topographic map in Figure 8.7, indicates
water depths in the bay outside the lagoon en-
trance and in the entrance itself. No depths are
given within the lagoon proper. Hydrographic
maps of other estuaries that I have seen provide
similar information. When they are available,
the U.S. Coast Survey topographic and hydro-
graphic maps can be used together to construct
a morphologic picture of an estuary for that
time. Those who are fortunate will find several
sets spanning a century, which together can
provide a fine sequence of morphologic evolu-

tion.

**Sedimentation Rates as Supplemental
Indexes of Change**

The process of sedimentation is the fundamen-
tal mechanism that creates morphologic
change. Many people are concerned about in-
creases in sedimentation rates—as an index of
rapid evolution of the estuary—that result from
land uses such as logging and residential
development on the estuary's watershed. Ana-
lysts should know the possibilities and pitfalls of
using sedimentation as another measure of
evolutionary rate. They can then respond more
effectively to public interest about how fast an
estuary is changing under natural conditions,
compared to how fast it would change if dif-
ferent types of human activities were allowed in
any of the three sedimentation locales: the es-
tuary itself, the watershed, or the littoral zone.

Sedimentation is a process of erosion, trans-
port, and deposition. All material eroded from
the watershed or adjacent littoral bluffs and
beaches may not be transported to the estuary,
and what is transported may not remain there.
Some of it is removed by the tides. Thus, simply
calculating erosion rates from the watershed
under natural versus cultural conditions will not
provide an accurate estimate of deposition rates
in the estuary.

The interpretation of evolutionary change
eventually focuses on the following questions:
 How fast did the estuary change in preculrural
times (essentially, before European man)? How
fast has it been changing in recent years (under
"current land-use conditions")? How fast will it
change in the near future (given increases or
decreases in human activity)? And how long
before the estuary is extinct as a wetland land-

cscape? An understanding of deposition rates in
the estuary helps to answer some of these ques-
tions, but good data are hard to come by. This is
one of the reasons why characterizing morpho-
logical change is perhaps more practical as well
as inherently more suitable for visual-cultural
assessment.

Human influences on how fast a natural
feature like an estuary will evolve into maturity,
senescence, and extinction are often best de-
scribed using estimated sedimentation rates
only as comparative measures for different in-
tensities of human activity. Conventional wis-
dom assumes that aboriginal man increased ero-
sion rates over those rates existing before
human habitation and that "modern man" has
sped up the rate of erosion even more. Table
8.1 illustrates this using hypothetical data from a
small estuary. Documenting the history of
deposition in relation to land use is difficult. The
best method is to analyze sediment cores from
the estuary. In the absence of cores, deposition
rates may be estimated. This involves a series of
speculative extrapolations from partial data on
streamflow, tidal volume, and the like to rates of
sediment transport into the estuary and then to
rates of actual deposition. The procedure be-
comes more speculative when one attempts to
reconstruct historical patterns.

The person who assesses visual-cultural
values of estuaries will probably operate within
the context of controversy over how fast the
estuary is evolving toward extinction and what
human activities in the vicinity of the estuary are
doing to speed or slow the process. The partici-
Table 8.1  The Role of Human Influence on Estuary Evolution, Using Estimated Deposition Rates for Five Historical Periods

<table>
<thead>
<tr>
<th>Historical Period</th>
<th>Rate (1,000 meters²/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preaboriginal:</td>
<td>20</td>
</tr>
<tr>
<td>Estuary evolving at a rate representative of truly natural conditions.</td>
<td></td>
</tr>
<tr>
<td>2. Aboriginal:</td>
<td>21</td>
</tr>
<tr>
<td>Hunter-gatherer tribes; no agriculture but occasional fires that could produce episodes of increased sedimentation.</td>
<td></td>
</tr>
<tr>
<td>3. European:</td>
<td>25</td>
</tr>
<tr>
<td>Farming and logging by settlers; occasional fires.</td>
<td></td>
</tr>
<tr>
<td>4. Contemporary:</td>
<td>30</td>
</tr>
<tr>
<td>Limited suburban and second-home development; limited logging, grazing, and farming.</td>
<td></td>
</tr>
<tr>
<td>5. Future:</td>
<td>35</td>
</tr>
<tr>
<td>Growth: Continued suburban and second-home development, logging, and road building; diminished grazing and farming; no removal of sediment from estuary.</td>
<td></td>
</tr>
<tr>
<td>Management:</td>
<td>28</td>
</tr>
<tr>
<td>Restrictions on rate and locale of building, logging, and roads to minimize sedimentation; removal of sediment from estuary.</td>
<td></td>
</tr>
</tbody>
</table>

Time to Extinction
(assumption: tidal prism to MHW is 1,400 × 10³ meters²)

Tidal prism divided by future “management” rate = 50 years.
Tidal prism divided by future “growth” rate = 40 years.

The Portrayal of Morphologic Evolution

Morphologic evolution can be depicted in both tabular and cartographic form. Figure 8.8 portrays morphologic evolution of Bolinas Lagoon over the 170-year period from about 1850 to 1970. This sequence was constructed from interpretations of historical maps, descriptive records, and recent air photographs. Table 8.2 provides areal data for morphologic units at four dates during the period.

It would be a simple matter to extend this portrayal back in time to the point where sea levels stabilized and the estuary began its evolution. The first map, dated perhaps two or three thousand years ago, would show a thin fringe of marsh with an incipient delta at the mouth of the major stream. The estuary would be quite open to the sea, with segments of a spit beginning to develop. This could be said to represent preaboriginal conditions, although at that date there may have been small bands of coastal Indians in the vicinity of the lagoon. A second map, dated about a thousand years ago, would show the stream delta somewhat enlarged, with two small islands emerging inside the lagoon. In the interim between the two maps, there would have been significant growth of the spit or bay mouth bar. A third map could be added for the period around A.D. 1500 to suggest how Bolinas Lagoon would have looked to the first European explorers, perhaps even to Sir Francis Drake himself, who is reported to have come ashore not far from this estuary. The main fluvial delta and the tidal delta (the two islands inside the mouth of the estuary) would have grown. The spit across the seaward face of the lagoon would now be more fully developed, but it still might be segmented, being breached by high tides and storm waves at regular intervals.

A sequence of morphological maps as described here is an effective means of communicating the history and future of evolutionary change. Used as a medium for public interpretation, the morphologic stages can be characterized along a time line beginning with stabilization of sea level (two to three thousand years ago) and ending with conversion to a coastal meadow. The information in Table 8.1...
and Figure 8.8 has been combined in Figure 8.9, to illustrate how alternate future patterns and time to extinction can be incorporated in one presentation.

**Marsh Invasion and Rate of Evolution**

The primary colonizers invading the bare mudflat help to determine the visual character of the estuary in both static and dynamic terms. In both respects the major distinction is between two common invaders, *Salicornia* (pickleweed) and *Spartina* (cordgrass). On the west coast of England, *Salicornia* is the dominant colonizer. Along the English Channel, *Spartina* (the aggressive hybrid, *S. townsendii*) has within several decades changed the visual character of a large number of estuaries. *Spartina foliosa*, a cousin of the European species, actively expands onto the lower elevations of selected California estuaries. *Spartina alterniflora* covers the marsh in estuaries along the Atlantic, and to a lesser degree on the Gulf Coast of the United States (this species is also prevalent on the east coast of South America and in the English Channel). *Spartina* is generally absent from the estuaries of Oregon and Washington.

There is a marked visual difference between marshes boasting the tall (three to five feet), wheatlike *Spartina* and those having a low (six to ten inches) mat of *Salicornia* (Figure 8.4). The thick, shiny-leaved cordgrass undulates in the shore breeze, presenting a clear edge to adjoining communities and to the bare mudflat. It browns in winter, whereas the pickleweed remains a grayish-green. Circular groves of cordgrass are commonly seen standing amid an ex-
Table 8.2  Morphologic Elements of Bolinas Lagoon Expressed as Acres and as Percentage of Total Estuary Areas, 1850–1970

<table>
<thead>
<tr>
<th>Year</th>
<th>Area of Lagoon</th>
<th>Marsh Acres : %</th>
<th>Mudflats Acres : %</th>
<th>Channel Acres : %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850</td>
<td>1216</td>
<td>157 : 13</td>
<td>909 : 75</td>
<td>150 : 12</td>
</tr>
<tr>
<td>1930</td>
<td>1130</td>
<td>72 : 6</td>
<td>653 : 58</td>
<td>402 : 36</td>
</tr>
<tr>
<td>1940</td>
<td>1096</td>
<td>88 : 8</td>
<td>742 : 68</td>
<td>266 : 24</td>
</tr>
<tr>
<td>1970</td>
<td>938</td>
<td>118 : 13</td>
<td>654 : 70</td>
<td>166 : 17</td>
</tr>
</tbody>
</table>

duces a different stage on which the tides produce different visual scenes.

When a viewer comes to an estuary, he or she may hold the image of a placid body of water. Confronting the estuary in reality may be disappointing because at low tide it looks like a drained reservoir. To characterize the estuary visually as a body of water is simply a technical error. As shown by the tide curve in Figure 8.10, the estuary is full only 20 percent of the time and empty 20 percent of the time. During flooding or ebbing (“midstage” in Figure 8.10), the mudflats are teeming with birdlife. Thus to overlook the visual attributes of a half-filled estuary is to neglect the most common as well as the richest stage of its tidal cycle.

**The Tides as a Unifying Medium**

In the tidal cycle we can find a solution to the old conflict between visual complexity and visual unity. Litton et al. (1974) identified three critical aesthetic criteria for the evaluation of environmental stimuli: unity, vividness, and variety. “Unity is that concern or expression whereby parts are joined together to a coherent and single harmonious unit” (p. 105). But, he goes on to say, “Variety does have a potential conflict with unity” (p. 107) unless there can be found some cohesion in diversity. (The terms variety, diversity, and complexity are used synonymously to denote the array of elements in a landscape display.) To see unity in a static landscape, the observer must infer some degree of structural cohesion or coherence among the parts. To see unity in the dynamic landscape of the estuary, the observer witnesses the repeated linking of morphologic units by tidal action. These units are the visible components of the estuarine system. Tidal flow is the dynamic medium that unifies them by immersion. This unifying process is given visual elaboration by the action of shorebirds at each tidal stage. As the incoming tide begins to join channel with mudflat, mudflat with marsh, the diggers move about poking in the mud for worms and small crustaceans, while the egrets and herons stand in deeper water and wait for fingerlings. Birds fly back and forth between channel, marsh, and mudflat, and the observer can see with ease the estuary as an integrated whole composed of distinct parts.
**Figure 8.9.** Estuarine evolution can be portrayed so that the time to “senescence” and, finally, “extinction” is seen as resulting from the decision to manage, or not manage, land use in and around the estuary. This idealized picture is created from existing knowledge and presents the question in terms of a choice to extend the life of the estuary. Dates and time periods will vary greatly among estuaries having different geographic properties.
Figure 8.10. Mean tidal curve for a typical Pacific Coast estuary (Bolinas Lagoon). The estuary is "full" only 20 percent of the time, "empty" only 20 percent of the time. The most common visual state is at "midstage," when the tides are ebbing or flooding. During this time the mudflats are covered with shorebirds, which add a rich dimension to the visual character of the estuary.
Evolutionary Changes in Visual Attributes of the Tidal Cycle

As an estuary ages, the visual attributes of the tidal cycle change. The direct changes are by now obvious and have been touched on above. A youthful estuary, when full of water, looks like a lake; when empty, it looks like a muddy, drained reservoir. A water-filled, mature estuary with extensive marsh appears as a grassland; but when flooded to three-fourths the height of the Spartina, it looks like a true “marsh.” A mature estuary lacking Spartina may be flooded above the height of the Salicornia or Distichlis, giving more the impression of a lake than a marsh. A senescent estuary with deeply incised channels among raised marsh beds may never give the visual impression of being a wetland if the flood-tide water is contained in the channels.

The morphologic evolution of a given estuary continuously reapportions a finite number of acres among the three morphologic units. For example, the more marsh, the less mudflat. Consequently, the kinds and abundance of birds that appear at different times in the tidal cycle will change with each stage of morphologic evolution. The mudflat supplies the food for the medium-sized and smaller shorebirds (Figure 8.11, bottom). Primarily diggers, the swarms of sandpipers, aggressive willets, dowitchers, dunlins, and oystercatchers are squeezed out as the ratio of marsh to mudflat increases. The mudflat stage offers prime visibility, a dance floor on which the trophic ballet is repeated with each tidal cycle. In the last stages of evolution, when the marsh abuts the channels, those smaller birds that still use the estuary will be hidden from view. The large birds—herons, egrets, and cranes—remain with an estuary after the mudflat unit has disappeared (Figure 8.11, top). They can stand knee-deep in the channels and feed, although they, too, will often be hidden from view as the channels become narrow and constricted.

Tidal Range and Visual Character: Tidal ranges (the vertical distance from MHW to MLW) vary from place to place. The variation is several feet in southern California and four times that in northern Maine. A average annual tidal curve similar to the one in Figure 8.10 could be used as the basis for calculating the area and duration of tidal filling. The vertical axis would represent the elevational scale, and once the estuary was surveyed, the area covered by—and the duration of—any stage of the tide could be calculated and graphically documented. A variation of this method would be necessary if no survey could be done. Using standard tide tables that note the time of day of high and low tides, an estimate could be made as to when a given stage would occur. Photographs could then be taken of the estuary landscape at, for example, low water plus one foot, low water plus two feet, midtide, low water plus three feet, and high tide. The photographs would be correlated with the duration (taken from the tidal curve) at each stage to document the visual attributes for different percentages of time for the daily cycle.

The tidal range of an estuary determines the range of visual conditions that will be produced. At low tide, estuaries with large tidal ranges, such as those in Maine, exhibit a great expanse of mudflat. Under these conditions the mudflat component of the estuary may visually overwhelm the presence of marsh and any remaining water in the channels. The relationship between tidal range and the rate and form of morphologic evolution is unclear. Some hypothesize that those estuaries with small tidal ranges evolve more rapidly than those with ranges of six feet or more.

The Geographic Context for Interpretation

In the Introduction it was suggested that the visual attributes of landscape—those inventoried in conventional assessments—were analogous to the static elements of a language, and the challenge was to find a way of using these elements in some dynamic grammar to convey meaning. Yet, pursuing the analogy further, a well-constructed sentence taken out of context may not be able to convey meaning adequately or accurately.

For any single estuary the meaning of morphologic change and rate of evolution emerges best when the case at hand is compared to other estuaries, measured against a theoretical norm, or set among the range of evolutionary conditions found within a geographic region. A good point of departure is the question of abundance and form of estuaries taken at the national scale.
Figure 8.11. Long-legged egrets, herons, and cranes (top) fish in the channels and rest in the marsh, employing the mudflat only minimally. Short-legged diggers (bottom) dine on mudflats and leave the estuary in its senescent state. (Photographs by Clerin Zumwalt. Courtesy of Audubon Canyon Ranch, Stinson Beach, CA.)
The American estuarine landscape varies dramatically from east to west. An equivalent length of Atlantic coast boasts nearly forty-two times more acres of tidal marshes and mudflats than California. Estuaries on the West Coast appear as small discrete entities compared to those along the Atlantic and Gulf coasts, where the estuarine landscape often seems ubiquitous.

Thus, in a geomorphic region where estuaries are comparatively few, a given potential increase in deposition rates from increased urbanization (Table 8.1) will be viewed differently than in a region where they are more abundant. Beyond this, the evolutionary status of other estuaries within the same geomorphic or geographic region will serve to judge more or less critically a given rate of change of the estuary in question. In a region where a good number of estuaries are thought to be on the verge of extinction, for example, there may be a desire to do whatever is necessary to slow morphologic change. (The political implications of this are discussed in the section “The Cultural and Political Context.”)

**The Present Evolutionary Status of Estuaries**

Placing estuaries into evolutionary categories, while useful for comparative purposes, involves some difficult taxonomic problems. Is a “youthful” estuary one with a high percentage (of total area) in channel and a low percentage colonized by marsh? Conversely, would a “mature” estuary have a high amount of marsh and relatively little channel? A successional model would certainly point to these as normative cases.

To test this approach, California estuaries are divided in Table 8.3 into three categories—Youth, Maturity, and Senescence—using percentage of channel as the single criterion. If this procedure is followed, the analyst must understand that the visual attributes may vary somewhat within each category, depending on the ratio among the three landscape elements—Channel, Mudflat, and Marsh.

The “youthful” estuaries have a high percentage of water and a low percentage of marsh, but the percentage of mudflat varies in this example from 3 to 13 percent. An observer would see “youthful” estuaries primarily as water bodies, but at low tide San Francisco Bay would appear much more “mature” than, say, Klamath River because of the significantly higher percentage of mudflat in the former.

At the other end of the spectrum, a truly “senescent” estuary like Elkhorn Slough (97 percent marsh) appears from the perimeter road as a flat plain of low gray Salicornia. Bolinas Lagoon could be said to be in “early senescence” with more than half of its acreage in mudflat. The ratio of mudflat to marsh (which can be used as a second criterion for more refined divisions) helps to distinguish “mature” cases from “senescent” ones. As an estuary moves from “maturity” to “senescence,” the ratio will diminish as mudflats are colonized by the expanding marsh. However, the divisions between these three categories in Table 8.3 are arbitrary in that no dictum states rigidly where they must be made. The analyst should be aware that labels such as these have powerful implications in the cultural and political context.

**Variations in the Morphologic-Evolution Model Resulting from Geologic Events**

If things have meaning only in relation to other like phenomena, then stark exceptions to the norm require some consideration here. This is not to say that the power of meaning increases (proportionately) to the magnitude of deviation, for those estuaries that conform nicely to the general model of evolution will have great interpretive value. The error of any general model or theory is to assume that all things behave in much the same way. In estuarine evolution the factors discussed that bear on the process and rate of change are (1) sea levels, (2) sedimentation, (3) marsh invasion. Human influences on sedimentation will be discussed again. An important determinant of morphologic change that has been omitted to this point is the large-scale uniform or episodic geologic event.

Subsidence or emergence of the coastal shelf are geologic events of long-term, uniform dimensions that affect the rate and form of morphologic change. Subsidence produces a flooding of the estuarine basin. Emergence lifts the basin and allows the descent of the marsh down the mudflat gradient to occur more rapidly than under stable geologic conditions. Because the effects of emergence or subsidence
Table 8.3 Evolutionary Status of Selected California Estuaries

<table>
<thead>
<tr>
<th>Location</th>
<th>Channel</th>
<th></th>
<th>Mudflat</th>
<th></th>
<th>Marsh</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth (66 percent water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bodega Bay</td>
<td>840</td>
<td>90</td>
<td>45</td>
<td>5</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Klamath River</td>
<td>4,250</td>
<td>80</td>
<td>165</td>
<td>3</td>
<td>870</td>
<td>17</td>
</tr>
<tr>
<td>San Francisco Bay</td>
<td>258,000</td>
<td>78</td>
<td>41,600</td>
<td>13</td>
<td>32,000</td>
<td>19</td>
</tr>
<tr>
<td>Smith River</td>
<td>3,825</td>
<td>76</td>
<td>230</td>
<td>5</td>
<td>920</td>
<td>19</td>
</tr>
<tr>
<td>Maturity (33 percent to 66 percent water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomales Bay</td>
<td>5,950</td>
<td>64</td>
<td>2,900</td>
<td>31</td>
<td>440</td>
<td>4</td>
</tr>
<tr>
<td>Drakes Estero</td>
<td>1,290</td>
<td>62</td>
<td>580</td>
<td>28</td>
<td>200</td>
<td>10</td>
</tr>
<tr>
<td>Eel River</td>
<td>2,300</td>
<td>59</td>
<td>500</td>
<td>13</td>
<td>1,050</td>
<td>27</td>
</tr>
<tr>
<td>Big River</td>
<td>120</td>
<td>47</td>
<td>90</td>
<td>35</td>
<td>45</td>
<td>18</td>
</tr>
<tr>
<td>Humboldt Bay</td>
<td>4,500</td>
<td>45</td>
<td>5,000</td>
<td>50</td>
<td>500</td>
<td>5</td>
</tr>
<tr>
<td>Senescence (33 percent water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolinas Lagoon</td>
<td>370</td>
<td>30</td>
<td>720</td>
<td>58</td>
<td>150</td>
<td>12</td>
</tr>
<tr>
<td>Ten-Mile River</td>
<td>40</td>
<td>24</td>
<td>100</td>
<td>58</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>Morro Bay</td>
<td>600</td>
<td>23</td>
<td>1,400</td>
<td>55</td>
<td>675</td>
<td>22</td>
</tr>
<tr>
<td>Elkhorn Slough</td>
<td>97</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2,840</td>
<td>97</td>
</tr>
</tbody>
</table>

Source: Unpublished data, California Department of Fish and Game, 1968. Acreage estimates were made from air photos. Tidal stages on the air photos were roughly the same for all estuaries inventoried. The evolutionary divisions are the author’s.

are often difficult to measure, assessors of estuary visual attributes are cautioned not to let this factor weigh too heavily on their methodology. The effects of earthquakes—an episodic geologic event—are, on the other hand, more easily seen in morphologic analysis and should be part of the context of any assessment, particularly in California, where active faulting is associated with a number of estuaries. Bolinas Lagoon is a case in point. Referring back to Figure 8.8 and Table 8.3, one can note that the morphologic sequence does not conform to the general picture of estuarine evolution. Between 1849 and 1929, instead of the area of marsh and mudflat expanding at the expense of channels, just the reverse occurred. The marsh decreased by 54 percent, the mudflats shrunk by 28 percent, and the channel expanded by 168 percent of the 1850 area.

Bolinas Lagoon lies astride the San Andreas Fault. During the 1906 earthquake in central California, the sediments in Bolinas Lagoon were probably compacted, thus lowering the surfaces of the mudflat and marsh units. In evolutionary terms the lagoon was "rejuvenated" and set back in its sequence, consequently extending its lifetime. Another earthquake of approximately the same magnitude as the 1906 event—expected by many to occur within the next ten to twenty years—may have a similar effect. One might conclude from the sequence of maps that the lagoon was set back in its evolution by approximately one hundred years. It is true that in 1970 the relative distribution of total estuary area among the three morphologic units was much as it was in 1850: Marsh, 13 percent and 13 percent; Mudflats, 75 percent and 70 percent; Channel, 12 percent and 17 percent (see Table 8.3). However, the total area of estuary is shrinking despite seismic rejuvenation—23 percent from 1850 to 1970. So, while Bolinas Lagoon exhibits a variation of the theme, its long-term pattern conforms to the general model of evolution.
Geographic Factors Affecting Deposition Rates: A Summary

Deposition is the primary factor causing morphologic evolution. It is possible to generalize roughly as to what causes more or less deposition in an estuary:

1. Climate: The higher the annual rainfall—all other things being equal—the more water available to carry sediment from the watershed into the estuary.

2. Orientation and exposure: Estuaries exposed to ocean storms will receive more littoral sediment than those protected by headlands and well-developed spits.

3. Areal ratio—watershed to estuary: The amount of sediment transported to the estuary increases with the size of the watershed. Small estuaries with large watersheds should evolve at higher rates than large estuaries with proportionately smaller watersheds.

4. Geologic factors: These include uniform and episodic events covered above, plus erodibility of the watershed and the proximate sources of littoral sediments.

5. Tidal factors: The unclear set of relationships between deposition rate and the mix of tidal factors includes tidal prism (volume of estuary) and tidal form (semidiurnal, diurnal, mixed, equatorial, tropic). Thus, while tidal factors are recognized here, no general relationship is stated.

6. Land use: Human influences on the process of sediment erosion, transport, and deposition have been touched on above and relate principally to land uses that either increase or decrease (dams) sediment transport to the estuary or remove sediment (e.g., dredging).

The unique combination of these factors operating on a specific estuary makes that estuary very different from even its next-door neighbors. This is said to alert the visual analyst to potentially great variations in morphologic process within the same geographic region. For example, two estuaries only ten miles apart with similar geology, soils, climate, and tidal form experience vastly different deposition rates. Annually, deposition occurs, per square mile, in Bolinas Lagoon at nearly three times the rate as in Tomales Bay to the north.

Bolinas Lagoon = 12,344 meters³/year/mile²
Tomales Bay = 5,120 meters³/year/mile²

A look at the geographic factors affecting deposition in these two estuaries suggests just the opposite case: higher deposition rates in Tomales Bay. The areal ratio of watershed to estuary is much greater for Tomales Bay (14:1) than for Bolinas Lagoon (9:1). Land use on the Tomales Bay watershed includes potato farming, dairying, and grazing, compared to less erosive land uses at Bolinas Lagoon. A closer look, however, leads to at least a partial explanation of the anomaly. Dams and lakes on the lower tributaries of Tomales Bay have captured much of the sediment. Bolinas Lagoon, on the other hand, lies near a formation of highly erodible sea cliffs that produce large amounts of sediment that enter the lagoon on each flood tide.

The lesson is clear: The documentation of estuary evolution as part of visual-cultural assessment should be place-specific, relying on as much local information as possible. Each estuary has its own story, and each can differ enough from its neighbor to yield fascinating, if perplexing, comparisons.

The Cultural and Political Context

On the geologic time scale, estuaries are an ephemeral landscape. Our view of estuaries has changed only within the last two decades. Historically, we have cherished only one morphologic unit—the channel. When mudflat or marsh encroached, we fought them back. Dredge and fill became a convenient means for keeping the estuary open and providing solid ground for buildings and roads. Much of the destruction of marsh and mudflat came just before our attitudes changed and indeed may have been the catalyst for the tidelands preservation movement. Between 1950 and 1964, New York State lost nearly 30 percent of its tidelands. Between 1940 and 1970, 90 percent of the salt marshes along the San Diego County coast in California were destroyed. By 1970, San Francisco Bay had lost about 60 percent of its marshlands.

Most estuaries, in terms of morphologic evolution, are several thousand years old, if we count from the time sea levels stabilized. The marshes
and mudflats destroyed by dredge and fill were created in part by natural processes of sedimentation, but often they were significantly enhanced by erosive human activities on the watershed. Hydraulic mining in the Sierra foothills during the California Gold Rush provided a large amount of sediment to nourish San Francisco Bay’s tidalflats. Humans have been a part of both the creation and destruction of the estuarine landscape. Consequently, the history of an estuary may be interpreted in one way or in another by various individuals or groups having a vested interest in its future.

An earlier study (Rowntree, 1975) documented how cultural context heavily influenced the interpretation of an estuary’s evolutionary history. Cultural context is the fabric of extant myths, folklore, and conventional wisdom held by individuals and groups about the manner in which an estuary evolves, how fast it evolves, and what role humans have played in that evolution. Political context is the manifestation of these beliefs in a more formalized decision-making environment. Normally, scientific interpretation of landscape process is free of influence by cultural-political beliefs. In this case, however, the folk interpretation of estuary evolution seemed to the scientists conducting
the investigation to be in conformance with general textbook models of estuarine process. Their "official" interpretation of morphologic change took this model for granted and overlooked important facts that would have produced a true picture of that estuary's evolution. The example is worthy of a brief summary.

Bolinas Lagoon was a lively shipbuilding and lumbering port in the latter half of the nineteenth century. As a result of a number of controversies over land planning, the lagoon had become in the late 1960s something of an icon for environmentalists and remained as part of a strong sense of place shared by the established citizens of two small communities on either side of the estuary. Part of this sense of place was a deep feeling for the history of the lagoon, its evolution, and the role people had played in that evolution. Folklore said that the lagoon was morphologically youthful prior to lumbering and shipbuilding in the mid-1880s. It could be used as a port, and there were few mudflats and marshes. Siltation from redwood cutting (to build San Francisco) transformed the embayment into the senescent, marshy lagoon. It was thought to be on the verge of extinction as a wetland ecosystem and useless as a port of refuge for pleasure boats.

A federal agency was called in to document the form and rate of evolution and to propose a set of recommendations for the estuary. The authors of this report were provided with maps by local residents that seemed to document morphologic transformation in the lagoon as a result of siltation from logging. The agency scientists apparently did not examine these maps closely, thinking that they were appropriate evidence for a "normal" sequence of estuary evolution. Consequently, the government report institutionalized an erroneous picture of morphologic change (Figure 8.12) that served as a foundation for public policy recommendations.

What can be learned from this? In the previous section it was shown that unique combinations of geographic and geologic factors produce significant variations in evolutionary pattern, even within the same region or locale, a fact that renders most evolutionary models useful only as a point of departure for interpretation. This requires that the visual analyst pay close attention to the specifics of the estuary in question without being unduly influenced by the local folk wisdom about morphologic change. Local sources of information are rich and in most cases invaluable if sifted and judged with a discerning eye. Beyond this, the reservoir of local belief about the past, present, and future of a wetland is in fact a powerful resource that can energize whatever interpretation the analyst feels is valid and appropriate.

Obviously, the myths and folklore about estuary evolution are not in themselves irrational or conspiratorial. Indeed, in the minds of those who believe in them, they are rational hypotheses about how things came to be. Depending on the outcome of his or her investigations, the analyst or interpreter may find himself working in concert with these beliefs or in opposition to them. Whichever is the case, he will have the advantage of the investment these people have made in their beliefs to power an interesting, yet accurate, interpretation of estuarine change.

Summary

A dynamic interpretation of wetlands provides a richer and indeed more valid picture of the landscape than visual analysis of static qualities. Estuaries are excellent candidates for this approach to assessment because they are visually dynamic at two temporal scales: the short-term cyclical and the long-term evolutionary scales.

The "morphologic evolution" of estuaries is susceptible to visual interpretation because it can be described graphically using changes in the three major units of the estuary: marsh, mudflat, and channel. What makes this approach more powerful is that these units are valid on both ecological and visual grounds. Thus visualized changes in morphology can explain fundamental changes in ecological structure and function.

The principal method for documenting morphologic change employs historical maps and air photos supplemented by data on rates of sedimentation. The method is straightforward, but it has many pitfalls.

The tides are a visually unifying medium for the diverse and complex estuarine landscape. The precise visual attributes of the tidal cycle change with the morphologic evolution of the estuary. A common set of six geographic factors determine evolutionary rate and form. These
factors operate uniquely on individual estuaries to produce greatly differing rates for even neighboring cases.

The visual analyst must be aware of folklore about the dynamics and evolution of cherished landscapes. These myths and beliefs have the same inherent weaknesses as generalized scientific models, even though they can facilitate acceptance and appreciation of truly valid interpretations of cyclical and evolutionary dynamics.

Postscript: Central Premise for Documenting Wetland Change

With the help of trained interpreters, landscape observers can grasp and benefit from a picture of wetland dynamics. All viewers of landscape seek meaning in one form or another and their search for meaning will follow certain lines of inquiry previously learned, particularly when these lines of inquiry pertain specifically to the type of landscape before them. Simply, viewers are taught to understand landscape dynamics, having been provided with the right conceptual and emotional tools.

To accept this premise, there has to be proof that ample concepts of both a general and specific nature are available to a majority of viewers that will enable them to comprehend cyclical and evolutionary change. General concepts of cyclical change derive from common experience with cyclical time—days and years—and the general concept of evolution derives from the experience of human physiological maturation and development. It would be difficult to argue that these common dimensions of the human experience did not provide at least a framework for the comprehension of cyclical and evolutionary change. Yet, what about the availability of more specific concepts—that can provide them with real points of reference to the idea of a functionally evolving estuary?

There is a prevalence of ecological ideas of an evolutionary nature in the popular literature. The concept of succession, for example, began as a scientific theory, but now it enjoys popular usage in nonscientific and quasi-scientific discussions of the world about us. (We know, too, that it was popular in sociology about fifty years ago.) More particularly, in the literature of wetlands, there is always some mention—even a theme—about evolution and change. Unquestionably, however, the challenge is great for the visual analyst and interpreter of wetland landscapes to create a valid and comprehensible notion of dynamic change as a fundamental attribute of the resource.

Visual-cultural assessment is commonly done under the auspices of a search for visual quality. Indeed, the field of visual analysis was mandated by the need to know more about the landscapes around us and to have a defensible method for justifying what we save and what we throw away. People want some objective measure of how the viewscape will change if certain processes, both human and natural, are allowed to exist. Thus it would seem that visual analysis would logically incorporate a concern for change. To speak to this concern, a land manager or planner ideally should try to comprehend how the landscape got to be the way it is, how fast it is likely to change as a result of natural processes, and how human influences on those natural processes can modify the rate and form of evolutionary change.

Certainly, this will not always be possible, and the approach should be employed only when dealing with a class of landscapes that are thought to be changing relatively rapidly. Estuaries—in fact, most wetlands—fall into this class. Thus incorporating short-term and long-term change into visual-cultural assessment is not just a matter of enriching interpretation. It is a case of documenting fundamental attributes of this type of landscape.

References


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PART IV

Wetland Visual-Cultural Valuation and Evaluation