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A COASTAL ZONE MANAGEMENT PROGRAM

JUN 5 1978

UPDATABLE COUNTY SHORELINE INVENTORY SYSTEMS:

A WORKING PAPER

by

Will B. Betchart

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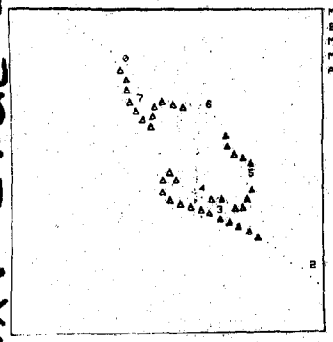

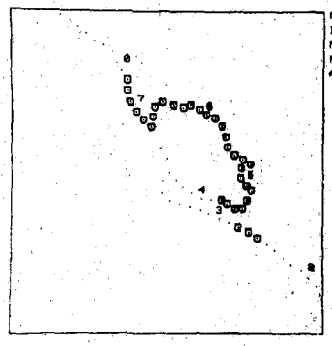

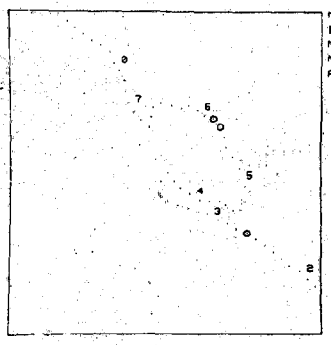

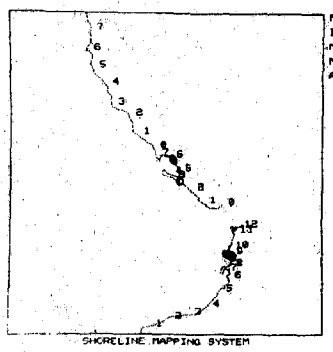

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Abstract

In light of the Washington State Shoreline Management Act of 1971 and the U.S. Coastal Zone Management Act of 1972, the development of county-based, updatable inventory systems to serve these management activities is pursued. Design considerations are identified and discussed with the finding that data use, phenomena represented, system convenience, and system technology are the most important considerations in this instance. A group of potential systems is then outlined, a group which includes progressive increases in comprehensiveness and cost. Broad conclusions are then articulated on the basis of this preliminary exploration of such inventory programs, three of the most significant being that 1) the design must be oriented toward serving specific data uses, 2) the system must be designed with the explicit intention of facilitating system evolution, and 3) developing stable variable definitions is particularly important. Recommendations are then made for further development of an example inventory system.

1 Introduction

The first step which the Washington State Shoreline Management Act of 1971 required of each local jurisdiction was completion of a shoreline inventory--an accounting of shoreline regions and their current conditions. The inventories have been essential references in developing and evaluating shoreline master programs (plans) and in reviewing substantial development permit applications. They are, however, only a one-time snapshot of shoreline conditions.

Since data on shoreline conditions as time progresses are obviously needed, a Washington State Department of Ecology (WSDOE) sponsored research project entitled "Shoreline Management Program Impact Measurement and Policy Projection" has been partially oriented toward this need. One objective of that project, which is underway at the University of Washington, is to develop a method for maintaining an up-to-date inventory of the shorelines. This working paper reports on the initial consideration of that task.

2 The Design Considerations

In developing such an inventory system the design considerations are the basic determinants of the system's structure. There is a large variety of such considerations which might be involved, but only a small number of over-riding considerations are usually recognized. Thus, depending on the particular considerations and emphases invoked by the designer, very different inventory systems may result. A wide range of potential design considerations has therefore been identified here, including

1) The identity of the data-gathering and supplying agency;

2) The geographic scope of the program;

3) The type of data to be supplied;

4) Precedents in data collecting;

5) Resource constraints;

6) A particular data property (such as its redundancy and the resulting possibility of statistical sampling and inference);

7) Utilizing available data gathering, storing and retrieving technology (such as computers);

8) Convenient data program operation;

9) Describing particular aspects of the real world with a stipulated accuracy;

10) Serving some particular user or use or combination of users and uses (Betchart, 1974).

If there is a single consideration which deserves more emphasis than others, this author believes it to be data use (Betchart, 1974). Indeed, one of the most serious drawbacks of current data systems is that they have been strongly oriented toward describing some aspect of the real world, such as land use or water quality, or toward using some special form of data program technology such as computers or environmental sensors. The result has been many data programs which are relatively useless. They often provide too much of some kinds of data and too little of others; indeed they frequently leave out some type of data which is crucial to using the types which have been included. Data use will therefore receive a principal emphasis in this discussion.

In recognizing the importance of data use one must not neglect other considerations in the design effort. Some of these aspects have been implicitly determined in establishing the State Shoreline Management Act of 1971 and the current research project. Others must be further considered in conjunction with data use.

For example, the Act places a strong responsibility on local jurisdictions such as counties and cities to actually manage the shorelines. The current research project has been focused on providing tools for an example local jurisdiction, Snohomish County. It is then easy to implicitly assume that Snohomish County should both be the data-gathering agency and constitute the data program's geographic scope. But what about the city of Edmonds? Should it have its own inventory system or should it be served by the county's? And, if this one local jurisdiction (Edmonds) should be served by the inventory system of a larger, encompassing jurisdiction (the county) isn't it also possible that there should only be one system for the whole state which serves all the local jurisdictions? These are crucial questions; questions which are not generally considered either explicitly or on the basis of a careful comparison of alternatives. Here, it is assumed that inventory systems should be operated by the counties and that each should provide any data needed regarding conditions or occurrences within the counties boundaries.

Similarly, interest in shoreline management and support from a shoreline management agency have implicitly directed the inventory system design toward shoreline data--descriptions of the natural character, land uses, and ownership of the shorelines. But what about other types of data such as demographic data and economic data? What about data on lands adjacent to the shorelines? Aren't these other types of data relevant? Isn't it presumptuous to think that a county would establish one data program for its shorelines and another for the remainder of its lands? Indeed, Snohomish County already has at least two such programs (assessor, and urban engineering) and furthermore, it appears to be very feasible to combine a shoreline data program with one of these or to combine all three. It must therefore be assumed that any data program finally implemented will, at a minimum, have to interface with these other programs and may have a scope that is not limited to shoreline regions and data.

At least with shoreline data there are no well-established precedents to constrain the data system suggested and similarly, even though resource consumption by the system would be important, such constraints are not firm. Thus, designs with a range of potential costs might be developed.

Redundancy as a property of shoreline data is far less relevant than would be the case in collecting rainfall data, for example. Shoreline conditions portray and are affected by a whole range of deliberate human actions and identifiable phenomena. It is therefore difficult to take a sample over some spatial region or period of time and to extrapolate that sample into a characterization of some larger region or time period. One would at least have to stratify his sample and, by the time all the significant bases for stratification had been identified and used, it might be just as simple to keep data on the whole population. This issue will be settled only after the other considerations have been brought to bear in designing the inventory system.

Available data program technology has been implicitly and subjectively considered in approaching this study; it has been thought that any updatable inventory system would take advantage of the efficiency and convenience of computer storage and manipulation of data. Even though this is probably realistic, computer capabilities must be considered a means rather than an end in themselves or prerequisite. Thus, potential use of computer technology must be subordinated to other considerations.

One of those other considerations is convenient data program operation; indeed this may be a principal motivation for computer use. However, convenience of operation has meaning only within the context of an inventory system which has some more definite substance, such as specifications for production. Thus, convenience must also be subordinated to other considerations.

The system's product (data) can be more definitely characterized in terms of the specific real-world phenomena which are to be represented. This is the "describing aspects with a stipulated accuracy" consideration and it is given considerable emphasis by the shoreline orientation of the present work. Still the shoreline orientation is derived from the intended use of the data in shoreline management, therefore the particular aspects of the world which are to be described can be intelligently specified only in light of a more detailed consideration of data use.

For these reasons the design process employed here will take on a sequential nature which considers data use, describing the real world, convenience, and technology in that order.

2.1 Data Use

It is convenient to consider potential data uses in terms of a number of distinct data users. Thus uses by federal, state, county and city agencies, modelers, and citizens will be discussed.

2.1.1 Federal Agencies

The National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce has responsibility for administering the Coastal Zone Management Act of 1972. In fulfilling this responsibility and in providing shoreline information to other federal agencies, it is assumed here that summary information for the county as a whole will be required at various times, that the information will be identical to that required by the state, and that if any more detailed information is required, it will also be required by the state.

2.1.2 State Agencies

Data uses by state agencies deserve more detailed consideration. Assuming that the WSDOE is the most significant user and would also require any data that other state agencies would use, four specific data uses have been identified.

2.1.2.1 Reporting

One significant responsibility of the WSDOE would be issuing periodic reports on shoreline character, use, and ownership to the federal government, to the state legislature, and to the public. Such reports probably would not occur more frequently than once a year and county inventory systems should have no problem providing data that frequently. In addition to providing summary information on the state as a whole, such reports might reasonably list data for each county on a comparable basis and furthermore, it might interpret the significance of those data in relation to previous years' reports. The need to aggregate data for the state summary and the need for comparability of data both among counties and with time are especially significant to data program design. Also significant, however, is the fact that the state may wish to report conditions for particular regions which do not consist of whole counties; regions such as the Pacific coast, the Puget Sound urban region, and various river basins. The county inventory systems should be prepared to provide data for such regions.

2.1.2.2 State Program Development

Planning of the state agency's shoreline management program and development of state policies will also require data from the various counties; indeed much of the required data would be the same as that required for reporting. In using those data for planning, however the state agency would need to place much more emphasis on data display and interpretation. For example, indicating trends would be especially important. Beyond this factual display of data describing shoreline conditions, other data would be necessary--data on the policies of various local jurisdictions, data on related activities of federal and other state agencies, data on particular projects being conducted by local jurisdictions, and data on the results of the permit and appeal process. Many of these data could be easily provided by a county inventory system.

State planning personnel also must use data to measure progress due to shoreline management and to predict future shoreline occurrences in the context of program development. These evaluations and projections must be provided on a statewide or multi-county, regional basis just as was required with the data. However, any such effort involves the use of models as well as the previously discussed data and other special data. These data needs will therefore be considered to be those of modelers.

2.1.2.3 Local Program Review

In addition to the previously mentioned data for other state agency activities, the review of local jurisdiction programs would require access to data specifically encompassing the geographic scope of each local jurisdiction and also to more detailed data on areas of particular importance. Thus, even the state's data needs will include information on relatively small geographical areas. The county inventory system could easily fill that need.

2.1.2.4 Permit Appeals

Finally, the WSDOE must decide whether to appeal a local jurisdiction's decision to grant a development permit and, if an appeal is warranted, the WSDOE must prepare the case for the appeal. This will require very specific data on the site in question, data on local and state policies, and data on precedents established in the context of previous permit proceedings.

2.1.3 County Agencies

Again assuming, on the county level, that a shoreline management agency will require any "shoreline" data needed by some other county agency, it is possible to identify four principal county data-using activities. Several of these are similar to those conducted on the state level, but even these have significant implications in data program design.

2.1.3.1 Reporting

The county agency will also have to report on shoreline conditions, in this case to the state, to the county commissioners and to the public. Its reports will have a significant difference in geographic view, however. County-wide summary data will be important as will data on sections of large regions which are of interest to the state. But many other smaller areas within the county may also be of interest, for example, urban areas, transportation corridors, or recreation areas. Thus one can anticipate the need to provide data on many more and much smaller regions.

2.1.3.2 County Program Development

Just as state efforts toward program development require data, so do county efforts and the same types of data would be required on the county level. Again, however, county efforts would require data with a finer geographic resolution. Model use would also be necessary and those models as well as their supporting data would have to possess similarly finer geographic resolutions.

The temporal scope of planning and thus the temporal resolution of both data and models would also have significant differences in going from the federal and state to the county level. Federal and state agencies would necessarily have a longer planning horizon than the counties and the data made available for use in county program development would have to allow for this consideration.

2.1.3.3 Coordination with Municipal Programs

In the case of counties the need to "review" programs of the local jurisdictions encompassed would be replaced by the need to "coordinate" the county program with various municipal programs. Data on these programs and shoreline conditions within their respective areas would again be required, however, and the geographic and temporal scales of those data would again be finer.

2.1.3.4 Permit Procedures

Counties are a principal permit issuing authority and that activity would require very specific data on any proposed development site and its surroundings. Although the required data may not be any more detailed than the data required in considering an appeal at the state level, much greater quantities of data would be required at the county level since every permit request would have to be considered. Again, data on policies and precedents, as well as on shoreline conditions, would be required.

2.1.4 Municipalities

Since municipalities also function as local shoreline managers, they must undertake the same reporting, program development, and permit considering activities as the counties do. They will therefore have very similar data needs. Again, however, municipal shoreline managers will be interested in subareas of their jurisdictions and these subareas will seem very small in relation to the regions discussed by county and state agencies. Indeed, because of the intense activity in urban areas and the potential for dramatic variations in short distances and over short time periods, municipal shoreline managers may require data on extremely fine spatial and temporal bases.

2.1.5 Modelers

The use of models in shoreline management is another concern in this research project. A special type of model is of interest--explicit, mathematical, cause-effect models which describe shoreline phenomena. Such models are not now widely available for use in the projection and prediction which are inherent in shoreline management activity. Another type of model is used in their place--implicit, mental descriptions of the same shoreline phenomena.

Both types of models require a data resource. The mental models and their use are usually based on the types of factual reports discussed in previous sections together with the experience and intuition of the user. The explicit models have more specific and demanding data needs. They require data for developing hypotheses, calibrating these trial models, verifying them, and finally as input for model use. If the inventory system is to adequately support modeling, each of these data uses must be served. Furthermore, data must be available for all the variables (causes as well as effects) which might be included in a model and they must be available on compatible temporal and spatial bases.

In considering modeling it is also important to realize that models, either explicit or implicit, will be used on each level of shoreline management activity--federal, state, county and municipal--and for each time horizon being considered. Thus, if explicit models are to be supported, they and their accompanying data requirements may pertain to the whole range of spatial and temporal resolutions discussed previously. Explicit models, if they are to be adequately developed for confident and successful application in shoreline management, are therefore going to be very demanding in the types and quantities of data required.

2.1.6 Citizens

People other than the responsible government agencies may well have use for data on shoreline phenomena. They may be developers who are interested in information relevant to their activity, conservationists who are pursuing their particular concerns, or other interested citizens. Such users will usually be interested either in data which describe the current conditions and past history of a particular tract or in locating a tract which has particular properties. Both uses would require data on a quite small geographic scale, a fact which further illustrates the diversity of activity levels which an inventory system might serve.

2.2 Describing Aspects of the Real World

Having recognized a variety of users and uses of data for shorelines management purposes, it is now possible to identify particular aspects of the real world that a useful data system would describe. It must be remembered that the inventory system being discussed would be operated by the county, would have a county-wide geographic scope, and would serve any need for "shoreline" data associated with that region whether the data user be a larger governmental unit (state or federal) or a small entity (municipal or citizen). Three specific types of information are relevant.

2.2.1 Shoreline Management Policies within the County

Explicit and precise statements of goals, policies, and regulations which apply to the shorelines within the county would be the first type of information which should be provided on an up-to-date basis. In addition to federal and state goals and policies, which would be broader and less detailed and which would also be less subject to change, these statements should include the goals, policies, and regulations promulgated for the county as a whole as well as those which apply to each of the municipalities. Deciding which parts of these policies and regulations should be included in the county inventory system is not particularly difficult; in order

to serve its intended use, the system must include all the pertinent information.

2.2.2 Shoreline Permit and Appeal Records

Information which indexes and summarizes the proceedings of substantial development permit and appeals actions relative to the county's shorelines is also an extremely important type of information which should be available on an updated basis. This information should then be backed up by the detailed records of such proceedings. Here too it is not difficult to decide what parts of this information should be included within a comprehensive, county inventory system. The detailed record must be complete; it should cover each permit application considered and it must record each relevant factor in considering, deciding upon, and justifying the case. The index and summary information should also be complete; it must provide an adequate summary of the issues, the decision, and the basis for the decision in each case so that any interested party can decide whether he wants to consult the detailed record.

2.2.3 Shoreline Conditions

The most obvious and most complex type of information which the inventory system should provide is information which describes actual shoreline conditions in terms of such factors as natural characteristics, uses, and ownership patterns. These factors are extremely variable, both on a geographic and temporal basis. They also include a very great range of more specific shoreline conditions which the data might describe. In fact, so many different conditions and so much temporal and spatial variety are involved that one simply must decide which of these aspects it is most important to describe within the inventory system. Such decisions may be the most difficult parts of system design. One example of this difficulty is related to potential data use in modeling. The purpose of modeling is to project or predict important shoreline conditions on a cause-effect basis. If a cause-effect connection is to be established or used, however, one must have data on the causes as well as on the results. Since current shorelines models are essentially nonexistent, one does not yet know which causative factors will be incorporated within the models. Still, data on those factors must be available if modeling or model use is to be successful and furthermore, it must be available on the "right" spatial and temporal basis. In considering the difficult decisions which must be made to provide the right data for the several shoreline management uses identified, several more specific types of data have been recognized for potential inclusion in the shoreline conditions section of a county inventory system.

2.2.3.1 Temporal Location

One aspect of the real world which is important no matter what condition is being described, is the time-of-occurrence of that condition. This property of the inventory system is especially relevant in the present case because inventories have tended to represent only one point in time and a specific recognition here is that data describing various times are needed. Two basic approaches are available for providing such time-based data, 1) inventories can be conducted at particular points in time, or 2) relevant changes can be observed and recorded as they occur. It is possible that some combination of both approaches would be desirable.

A crucial issue in either case is the time step (or temporal resolution) used. One might perform yearly or monthly or weekly inventories, or he might itemize and incorporate data describing changes on these or other intervals. He might also develop an inventory system which incorporated a variety of time steps depending on the variability and the ease of characterizing the particular conditions in question. In any case, however, conditions are then generally assumed either to be unvarying during the interval between inventories or updates or to be changing linearly with the passage of time.

2.2.3.2 Spatial Location

Just as the time of any described condition is important, so is its location in space. In this case, however, one has a potential interest in three dimensions rather than just one and thus spatial characterization is more complex. Indeed, one's first decision must be whether to use a zero-, one-, two-, or three-dimensional scheme for spatial location and in dealing with shoreline phenomena, several different choices might be defended. If one were going to provide only data which pertained to the county as a whole, a zero-dimensional system would be used, since no other spatial characterization would be necessary. On the other hand, shorelines lend themselves to linear spatial characterization, since--for a given coastal region, lake or river basin--one can specify coastal or lake shoreline location in terms of miles along the shoreline from some point or river shoreline location in terms of miles from the mouth. Two-dimensional spatial location is most commonly used where characterizing the variability of conditions throughout a region. Several different schemes can be used including

1) Latitude and longitude,
2) Township-range-section,
3) Established coordinate systems such as the Washington State system, the Universal Transverse Mercator system,

and the 1/16 section system used by the urban system engineering study (Systems Control, Inc., 1973) in Snohomish County,

4) Census tracts,
5) Inclusion within a particular municipality,
6) Street addresses,
7) Assessor's numbers,
8) An arbitrary rectangular grid system,
9) An arbitrary polar coordinate system,
10) Owned parcels,
11) Legal descriptions,
12) The identity of adjacent pieces, or
13) Some combination or variation of these.

Of course, a three-dimensional system could also be used which would probably combine a two-dimensional system with 1) height above or below mean sea level, or 2) height above or below ground surface level. A combination of schemes which provided spatial location in terms of, for example, one- and two-dimensional information might be used.

In the case of spatial characterization a crucial issue is whether one wishes to describe conditions with respect to particular regions, assuming some form of uniformity within such regions or with respect to "points" assuming some sort of systematic change between points. This choice will markedly affect the type of spatial locating system adopted and the interpretation attached to that system. The option of describing conditions within identified regions appears to be generally more useful in the present case, thus "spatial location" will constitute an identification of a particular region or subregion.

2.2.3.3 Natural Character of Regions

One type of information, which is of interest both in simply describing available shoreline resources and also as potential causative factors for use as inputs to models, is data on the natural characteristics of such regions. "Natural" is defined here to include all the physical, chemical and biological features (as opposed to cultural features) of a region, including modifications in those features which are due to human activity. As can be seen from the comprehensive list of those conditions which has been presented as Table 2-1, an extremely wide range of natural features is of potential interest. In some cases the potential attributes of a condition are obvious, in other cases they have been listed in the table, and in others (such as geology and water quality) no attempt to develop more specific means for characterization has been attempted. The list is to serve as a tabulation which can be revised as other potentially significant

Table 2-1. Potentially significant natural characteristics of regions.

Area
Miles of Shoreline
type (shoreline, plain land)
subtype (marine shoreline, fresh shoreline, inapplicable)
subtype (main land , island, open water)
subtype (protected, unprotected, inapplicable)
subtype (no fresh water influence, fresh influence, major fresh entrance, river, lake, stream, inapplicable)
subtype (type of river (estuary, pastoral, floodway, boulder), type of lake (f(mean annual flow through, volume, depth, area)), type of coast (accretionary, marginal, erosionary), or inapplicable)
subtype (high bank, low bank, inapplicable)
subtype (water surface, tide flats, beach, marsh, swamp, dunes, flood plain, terrace, bluff, channel banks, channel, uplands, inapplicable)
subtype (natural, modified, inapplicable)
water quality
water flow levels (mean annual, once in 10-year minimum, once in 10-year maximum)
tide levels (mean high, once in 10-year high, mean low, once in 10-year low)
mean depth of water or elevation of tract
mean slope of tract
mean orientation of tract
view?
depth to bedrock
depth to fresh groundwater
distance to surface water
geology
minerals
susceptibility to earthquakes or volcanoes
susceptibility to slides
soil/bottom type
soil/bottom transmissibility
fertility (soil or water)
precipitation
snowfall
solar radiation
temperature (winter mean, summer mean, mean of yearly lows, mean of yearly highs)
winds (direction and velocity)
vegetation
animals
unique or fragile features

natural conditions are recognized and which can then be drawn upon in actually synthesizing an inventory system.

Clearly, one of the most basic natural characteristics of a given tract of the earth is its surface area. Where that tract is shoreline, the length of the shoreline is also of interest.

The "when" part of this second statement indicates a second basic group of natural characteristics that are of interest--the distinctly different types of regions which the tract might be. Is it shoreline land or other land? Is it marine shoreline or freshwater shoreline? Is it relatively protected from wave action or not? Many of these characteristics are of critical importance in determining appropriate shoreline uses.

The one most intricate type of distinction between different types of rivers, lakes, and coastal areas deserves further elaboration. The types of rivers and types of coast have been identified on a basis similar to that suggested by the Washington State Department of Ecology (WSDOE, 1972a) and used by Snohomish County Planning Department (SCPD, 1973) in their initial inventory. There is also a need for a similar means for classifying lakes. Although such a scheme has not yet been developed, it should consider such factors as the retention time of the lake and the relationship between the lake depth and its area.

The other natural characteristics which might be described include physiographic, geologic, climatic, and other aspects of the region.

2.2.3.4 Ownership of Regions

Several different aspects of the ownership of the region would also be of interest. A preliminary list of these aspects is given in Table 2-2. Of course the relevance of some items in this list depends on the overall geographic resolution being used in the inventory system.

2.2.3.5 Uses of Regions

The uses which occur in a given region are still other major characteristics of interest. As can be seen from Table 2-3, there are at least four aspects of use which are potentially significant: 1) the actual use, 2) the intensity of that use 3) other potential uses, and 4) the carrying capacities of the region for the existing and any potential use. Furthermore, when one is classifying uses, there is a potential for using

Table 2-2. Potentially significant ownership characteristics of regions.

type (private or public)
subtype (corporate, nonprofit organization, partnership, person, federal, state, county, municipal, port districts, other districts, other)
type (subdivided, unsubdivided, inapplicable)
type (part of small holding or large)
type (multiple ownerships or single)
less than fee interests?
leases?
private access?
public access?
Owners' names

Table 2-3. Potentially significant aspects of region use

- Actual use
  - residential
    - single family
    - duplexes and triplexes
    - garden apartments (up to 3 stories)
    - high rise apartments
    - trailor
    - other
  - commercial
    - retail
    - office
    - other
  - industrial
    - light manufacturing
    - heavy manufacturing
    - extractive
    - other
  - service
    - education
    - religious
    - health
    - correctional
    - military
    - governmental offices
    - other
  - recreational
    - skiing
    - hiking
    - camping
    - boating
    - bicycling
    - motorcycling
    - snowmobiling
    - other
  - circulation
    - highway
    - railroad
    - airport
    - seaport & sea lanes
    - other
  - utilities distribution
    - electric
    - gas
    - water
    - sewer
    - telephone
    - oil
    - other

Table 2-3 (cont.)

- agriculture and aquaculture
  - crops
  - orchard
  - pasture
  - intensive animal rearing
  - other
- commercial forest
  - sustained yield
  - other
- undeveloped
  - resources harvested (e.g. hunting, minor wood cutting)
  - resources not harvested

Intensity of use (e.g. residential units/acre, recreational visitor days/acre-year)

Potential uses

Carrying capacity for any potential use

several levels of sub classes. Unfortunately, no widely accepted scheme for use classification exists; the one given here has been synthesized from WSDOE inventory guidelines (1972a), the SCPD inventory summary (1973) and Anderson, et al. (1972). It must be considered preliminary and must be subjected to extensive discussion and developed into a consensus-based, relatively stable form before actual implementation in an inventory system.

2.2.3.6 Economic Character of Regions

Economic factors provide another significant type of real-world description and several have been listed in Table 2-4. Clearly these factors will be both causes and effects of activity in shoreline regions and they therefore deserve some representation within a county inventory system.

2.2.3.7 Cultural Characteristics of Regions

Data which describes the presence, the artifacts, and the activities of people are also important parts of a complete regional description. Thus, a preliminary list of potentially significant factors has been presented in Table 2-5. Such factors as the accessibility of the region being considered, its population, the characteristics of its population, and the public services available are of interest.

2.2.3.8 Management Designations Applying to a Region

Governmental designations which apply to the region are also of potential importance. Two such designations are explicit parts of the shoreline management program--the concept that some regions are of statewide significance (Washington Laws, 1971) and the idea that areas should be assigned a certain environment designation (WSDOE, 1972b). Other similar management designations including zoning assignments, plans, and individually permitted uses should also be recognized. Note that this information would only describe the "zoning" designation which was given to the region; the description of the regulations which were associated with that designation would be given as part of "management policies" information discussed in Section 2.2.1.

2.2.3.9 Surface Cover of a Region

Another type of real-world description which might be used is the concept of surface cover. Anderson et al. (1972) of the U.S. Geological Survey suggests the basic types of cover indicated in Table 2-7. The classification scheme was developed

Table 2-4. Potentially significant economic factors in a region

Land value (assessed, $/acre)
Improvements value (assessed, $)
Production (in agriculture, aquaculture, etc.)
Monetary value of production (sales or surrogate)
Jobs (# and fte's)
Earnings ($/fte-year)
Sales taxes generated
Tax rate

Table 2-5. Potentially significant cultural features of a region

Accessibility
- miles to interstate entrance/exit
- miles to federal or state primary highway if closer
- miles to arterial street or state highway if closer
- miles to public street or road if closer.

Number of businesses
Number of housing units
Public accommodations
Recreation facilities
Population (residents)
Per capita income ($/resident)
People per family
Socio-economic and ethnic types
Historic importance
View from other parcels obstructed by features on this parcel?
View from this parcel obstructed by features on other parcels?
Shore works: (including dredging or beach feeding)
Power use
Public water supply district
Water pressure zone
Water metering
Water use
Sewer district
Waste water generation
Solid waste generation
Water traffic generation
Percent impervious areas
Percent directly connected impervious areas
School district
Legislative district
Voter information

Table 2-6. Potentially significant types of management designations for a region

Shoreline of Statewide Significance or Other Shoreline

Environment Designation (e.g. urban, rural, conservancy, natural)

Zoning designation

Plans

Use explicitly permitted

Table 2-7. Types of surface cover of a region

Urban
- residential
- commercial
- industrial
- extractive
- transportation/communication
- institutional
- strip or cluster of mixed uses
- unused
- open

Agricultural

Range

Forest

Water

Wetland

Barren

Tundra

Snowfields

with a view toward interpreting and recording information from aerial photos. No consideration was given to the subsequent use of the data and as can be seen from the table, the scheme consists of a potentially troublesome combination of land-use and natural-characteristics information. It is thus an example of technology- or technique-oriented design of a data program, one whose usefulness must be carefully considered.

2.3 Convenience

The third especially important design consideration which has been recognized is convenience; the inventory system should be both convenient to use and convenient to operate.

Perhaps the critical issue in convenience of use is the ease with which data are available from the system. Both current and historical data should be readily available. Ideally, one would have a great deal of flexibility in choosing and aggregating subregions for which data were desired and one would also want to obtain suitable summaries of those aggregations. Furthermore, one would want to obtain those data efficiently and rapidly. It would be particularly convenient if any particular user could obtain the data immediately at his office. The possibility for several users to be using the same data simultaneously is an important prerequisite for this type of convenience.

The inventory system would also be enhanced by convenience in updating since this would affect the up-to-dateness of the information and this, in turn, would affect the information's usefulness. It is therefore important for updating to be easy and for routine updating to be practiced.

One special aspect of convenience deserves specific consideration. It is important that efforts to provide standardization and comparability in time and among counties and states avoid the pitfall of regimenting local jurisdictions to the extent that they feel their uses cannot be conveniently served.

Of course, simplicity of system operation would be important in both data retrieval and updating.

2.4 Technology

Available inventory system technology was the fourth major design consideration identified. Three basic techniques exist for storing, distributing, and retrieving the types of data being discussed. First, one can create a file of cards or papers, much like a library card catalog, in which information is stored in some structured way and to which new information

can be added. Such a system is not particularly convenient, however, One must go to the file to use it and simultaneous retrieval and use of information would be limited. Second, one might publish the system data in books; books which any user could purchase and thus have immediately available. However, books, especially data books, are produced very slowly; indeed, they are usually out-of-date as soon as they are finally made available. They are also difficult to update and they do not provide suitable flexibility in obtaining various temporal and spatial combinations of data. On the other hand, the third possibility--computer storage and retrieval of data--is especially well-suited to each of the "conveniences" which are desired. A central "file" of data is kept and it can be easily updated. It can also be easily drawn upon and those data can be transmitted by telephone line to any office which has a telephone and an appropriate computer terminal. Many people can draw on the file simultaneously and each can select the particular combination or aggregation of areas and data which suits his use. Furthermore, computer programs can be provided which direct the compilation of appropriate summary statistics for the particular collection of data being requested. Use of computer technology will therefore be pursued.

3 Design Criteria

The preceding discussion of design consideration can now be summarized in the form of explicit and concise design criteria. Table 3-1 is such a list. Of course, the table is not the list; it must instead by considered preliminary, subject to revision, and probably only one of many lists which would work. Indeed, the improved opportunity to revise and augment the list is a principal motivation in making it explicit. The more obvious motivation, however, is using the list in making the specific decisions which are required to further develop the structure of an inventory system or of alternative inventory systems.

Table 3-1. County inventory system design criteria

1. The county inventory system should serve all the "shoreline data" needs of parties who might use data about that county.

2. The system should be specifically designed to be flexible so that it can evolve over time.

3. The system should be able to interface with, augment, and possibly merge with other data programs within the county.

4. The system should be oriented toward serving data uses

a) It should contain historical information so that changes with time can be studied and assements of shoreline state at any past time can be made.

b) It should incorporate variable definitions which are relatively stable with time so that they will facilitate temporal comparison.

c) It should facilitate and emphasize updating so that current information is available and assessments of current shorelines state can be made.

d) It should be structured to be applicable to all types of shorelines so that different counties (and even different states) can use the same definitions of variables and will thus provide information which can be compared and aggregated.

e) It should use basic spatial units which provide for flexible aggregation of subareas into relevant larger areas.

f) It should facilitate production of summary statistics for these larger areas.

g) It should recognize and be able to serve the large range of spatial and temporal resolutions in which various users will be interested.

h) It should provide for identifying shorelines regions with distinct combinations of properties (e.g. sandy, agrading, beaches which are protected and accessible) and for summarizing the other characteristics of such regions.

i) It should include data on causative factors in shoreline phenomena as well as effects.

j) It should anticipate data needs.

5. The system should contain information on

a) The goals, policies, and regulations which apply to the county, to each of the municipalities, and to the various types of "Zones" within the county or its municipalities.

b) The actions taken on each substantial development permit application which involves a place within the county.

c) The shoreline conditions including temporal location, spatial location, natural character, ownership, use, economic nature, cultural character, and management designations pertaining to particular regions.

6. The system should emphasize convenience

a) Data should be immediately retrievable at principal users' offices.

b) Many users should be able to retrieve and use the data simultaneously.

c) Updating should be a routine operation.

d) Operating the system should be a simple and inexpensive task.

e) In the effort to standardize the definitions of variables, care should be taken to avoid regimenting local jurisdictions.

7. The system should take advantage of computer-based information storage, retrieval, and manipulation technology.

8. The system must be within economic reach.

4 Alternative Inventory System Designs

Based on the previous discussions a group of alternative designs for an inventory system have been developed. Each will be described here in terms of the information, the updating procedures, and the data processing programs it would contain. Then, it will be evaluated in terms of the extent to which it would meet the design criteria, the uses it would adequately serve, and the costs it would entail. The alternatives are presented in a progression from the simplest and least expensive to the most elaborate and expensive.

It must be noted that all of the alternatives should include information on shoreline management policies within the county and information on actions taken within the permit system. The design of these portions of the total data system should be relatively obvious, however. The inventory system design with regard to "shoreline conditions" is not obvious and that aspect of the design will therefore be of concern here.

4.1 Version 1

The simplest design of the inventory system is just a means for locating and tabulating shoreline uses and has been presented in Table 4-1. It has been motivated by a concurrent effort in this project to obtain data from aerial photos on what shoreline uses occurred at various times in the past. It suggests subdivision of the shoreline into 0.2 mile chunks and then determination of the percentage of that area devoted to each class of use of a particular time. The system requires a distinct tabulation of uses at any other time which is of interest, for example, at the time for which another set of photos are available. This repetition of data on unchanged conditions, together with the large number of zeros which the system must store relative to land uses which don't apply to each chunk, contribute an element of inefficiency to the system. Still, if this basic approach were used, one would want to subdivide the shoreline into some collection of basic units to facilitate photo interpretation and data coding. Programs could then be written to compute the total amounts of land within each use at the particular times for which data were available and for a variety of regions including the county as a whole, each municipality, any basin, or a particular reach of shoreline within a basin.

Unfortunately, the system provides only minimal satisfaction of the criteria which have been developed. Although it does serve some of the need for shoreline data, it hardly makes a dent in that need. Little consideration has been given to the system's flexibility and its interaction with other data programs.

Table 4-1. Information contained in version 1

Version 1 uses parcels of uniform size equal to 0.2 miles of shoreline. One data entry or card with the information identified below would be required for each parcel.

Type of Information			Data Columns Required
Spatial Location & Natural Character (size)	Basin identity		4
	River (or coastal) mile--i.e. location of parcel centroid to closest 1/10 mile; in this case 0.1 means shoreline between mile 0.0 and 0.3 and 10.3 means between 10.2 and 10.4.		5
	Right or left bank (R or L) facing downstream or toward mile zero.		1
	Municipality (letters A through Z, one letter assigned to each municipality, Z means unincorporated).		1
Temporal Location & Use	Actual use 1969	% residential % commercial % industrial % service % recreational % circulation % utilities % agriculture % commercial forest % undeveloped	2 columns each = 20
	Actual use 1955	% residential % commercial % industrial	20
			51

Although it does contain historical information, that information is available only at particular instants of time and the only way to obtain current data is to perform a completely new inventory of uses. Updating is therefore not a convenient, routine operation. Although it does provide for various spatial aggregations in summarizing shoreline use, it includes no information which describes the natural features, ownership patterns, or other aspects of those regions. Certainly none of the causative factors which have led to those uses have been described.

The system would therefore serve only as a means for reporting shoreline use at a few distinct instants of time and for various specific locations or aggregations of locations. Although this could be done at a relatively low expense, much better results might be obtained at little additional expense.

4.2 Version 2

Some of the undesirable features of Version 1 can be overcome with the slight change in system structure indicated in Table 4-2. One can subdivide the area with the idea of forming contigious parcels which each have a uniform regional use. One must then provide a measured length of the shoreline included in each parcel, but he avoids the need to record zero percent for each use which does not apply. It may also be possible to considerably decrease the total number of parcels needed to describe the shoreline. A slight complication occurs, however, when an inventory study for updating the data identifies a change in shoreline use which applies to only part of the parcel. One must subdivide the parcel into two or more new parcels and provide an entry (card) for each. That scheme should be workable however, since earlier uses will be known. A group of data processing programs similar to those mentioned with Version 1 can then be used for data retrieval and summary.

The more efficient storage of information is a significant property of this data program structure, a property which may become even more significant as more elaborate inventory systems are considered. However, since no information has been incorporated in Version 2 which was not also included in Version 1, the new version has all Version 1's shortcomings which stem from this lack of more complete data. It will serve the same uses as Version 1, but have a lower cost.

4.3 Version 3

A third possibility would be to provide an additional, more widely used system for spatially locating the parcel of land being described; indeed this scheme can be used in defining

Table 4-2. Information contained in version 2.

Version 2 uses parcels which are contiguous and of uniform use. One data entry or card is again required for each parcel.

Type of Information		Data Columns Required
Spatial Location	Basin identity	4
	River (or coastal) mile--i.e. location of parcel's centroid to closest 1/10 mile	5
	Right of left bank (R or L)	1
	Municipality (A through Z)	1
Natural Character (size)	Miles of shoreline in the parcel	4
Temporal Location & Use	Actual use 1969 (one of 10 types)	1
	Actual use 1955 (one of 10 types)	1
		17

the parcels as is illustrated in Table 4-3. The "Range-Township-Section" system is the basic legal means for locating land and therefore much of the interest in shoreline use will be in conjunction with such information. It has therefore been suggested that one consider each 1/16 section (quarter of a quarter section) as a basic spatial unit. Information would then be developed concerning shoreline location in terms of river miles and municipalities and also concerning the number of miles of shoreline included and the percentages devoted to each type of use with specific reference to each 1/16 section. When one then wanted to develop more current information for inclusion in the data base, he would develop new estimates of shoreline use percentages for each 1/16 section based on more recent aerial photos or some other record. Of course, a similar set of programs to retrieve, display, and summarize this information could be developed.

The new information on spatial location is especially important in making the system more useable on the local level where concern is more likely to be directed toward specific locations or parcels. However, many of the inadequacies which were associated with the previous versions still apply. In particular, updating is neither emphasized nor facilitated by the system and the information it contains will satisfy only a portion of the "reporting" needs and not much else. Cost would not be a serious impediment to the system.

4.4 Version 4

The fourth alternative combines the location and subdivision strategies of versions 2 and 3. As is suggested in Table 4-4, the shoreline of each 1/16th section is subdivided into parcels which are contiguous and of uniform use. A data entry or card is then prepared for each parcel including the indicated information on spatial location, size, and shoreline use at various times. The modification provides the same improved efficiency in information storage over version 3, as was realized in going from version 1 to version 2. It also provides the means for more conventional spatial location which version 2 does not. However, updating would still be a major undertaking and the total information resource is simply not adequate.

4.5 Version 5

The system described in Table 4-5 is specifically oriented toward better satisfying the desired capability for and emphasis on updating. Exactly the same types of information would be included in the system but, rather than attributing given conditions to a single date, they would be attributed to a period.

Table 4-3. Information contained in version 3.

Version 3 uses parcels of uniform size equal to 1/16 section and provides a data entry (card) with the following information for each.

Type of Information			Data Column Required
Spatial Location	Range (03-11)		2
	Township (27-32)		2
	Section (01-36)		2
	1/16th section (01-16)		2
	Basin identity		4
	River (or coastal) mile--i.e. location of shoreline within 1/16 to nearest 1/10 mile		5
	Right or left bank (R or L)		1
	Municipality (A through Z)		1
Natural Character (size)	Miles of shoreline in the 1/16		4
Temporal Location & Use (same as Version 1)	Actual use 1969	% residential % commercial % industrial % service ⋮	20
	Actual use 1955	% residential % commercial ⋮	20
			63

Table 4-4. Information contained in version 4

Version 4 uses parcels which are contiguous and of uniform use and which are totally located within a given 1/16 section.

Type of Information		Data Columns Required
Spatial Location	Range (03-11)	2
	Township (27-32)	2
	Section (01-36)	2
	1/16th section (01-16)	2
	Parcel number	2
	Basin identity	4
	River (or coastal) mile--i.e. location of parcel centroid to nearest 1/10 mile	5
	Right or left bank (R or L)	1
	Municipality (A through Z)	1
Natural Character (size) (same as version 2)	Miles of shoreline in the parcel	4
Temporal Location & Use (same as version 2)	Actual use 1969 (one of 10 types)	1
	Actual use 1965 (one of 10 types)	1
		27

Table 4-5. Information contained in version 5.

Version 5 uses the same types of parcels as Verison 4 but it subdivides parcels creating at least two new entries (cards) whenever part of a parcel changes its type of use. It also provides a completely new entry (card) for a parcel whenever the whole parcel changes use. It saves the old entries (cards) in order to preserve information on historical uses.

Type of Information		Data Columns Required
Administrative	Person entering, correcting, or updating	2
	Date of entry, correction, or update	6
Temporal Location	Date of earliest known applicability	6
	Actual date of change, or did change occur prior to this date of earliest observation? (A = actual, P = prior to)	1
	Date of latest applicability (day before date on new card for changes if this card is an old card; should read 99/00/00 if this is a current card).	6
Spatial Location	Range (03-11)	2
	Township (27-32)	2
	Section (01-36)	2
	1/16th section (01-16)	2
	Parcel number for this entry	6
	Previous parcel number(s) (number or numbers which identify the previously applicable entries for this particular parcel)	12

Table 4-5 (cont.)

Spatial Location (cont.)	Basin identity	4
	River (or coastal) mile	5
	Right of left bank (R or L)	1
	Municipality (A through Z)	1
Natural Character (size)	Miles of shoreline in the parcel	4
Use	Actual use during the time of applicability of this entry (one of 10 types)	1
		63

Thus, when one made an entry or change of information, he would note the earliest known date of applicability for that information and the information would be viewed as "current" until a new entry were made. At that time a "date of latest applicability" would be inserted on the old entry (which would then be saved) and a completely new entry would be created for the new situation which pertained after that date. Changes could thus be incorporated in the data base as they occurred from information obtained about completed buildings and permits or licenses for certain types of activity. Note that administrative data on the person entering the updated information as well as on the date of entry are also shown. Part of the motivation for this information is to force a distinction between the date of information entry and the date of earliest known applicability. In addition to encouraging routine updating, this system provides one the opportunity to inquire about shoreline conditions as of any particular day. Of course, the accuracy of the system's response is dependent on how completely and rapidly the system for discovering and noting real-world changes incorporates these changes into the data base. Again, note that if only part of a parcel has undergone a change, that parcel must be subdivided and a new entry created for each subparcel, each having a new parcel number which might be determined automatically. It would then be possible, however, to combine such a new parcel with an adjacent parcel that has the same properties, thus characterizing the 1/16th section with a minimum number of parcels at any given time. Updating need not occur only by this routine means for incorporating observed changes. A new set of aerial photographs might become available and one could discover shoreline uses on those photos which had not yet been incorporated in the data base. The changes should thus be entered, but one could label them with a special symbol (p in Table 4-5) to indicate that the date of earliest known applicability was the date of a photo or observation rather than the date of actual occurrence.

Of course, a different set of computer programs would be required to retrieve and summarize these data, and they could be written to do so with respect to instants or periods of time, with respect to locations in terms of range-township-section-sixteenth, municipality, or river basin and mile, or with respect to some combination of these indices. A special program would be needed if new parcel numbers were to be automatically selected.

A significant advancement has therefore been made toward meeting the criteria indicated in Table 3-1. Although, only very limited consideration has yet been given to the first three criteria, the improved system can now more conveniently serve the data uses for which it has adequate information, it

has more flexibility in providing information on shoreline conditions at any past time, and routine and continuous updating to provide more current information as well as historical information is emphasized. The system is still significantly weak in terms of information content, however, and it is therefore useful mainly for reporting on shoreline use over space and time. A significant increase in operating cost would occur because the data system would now have to store entries for each parcel for each period during which a significantly different condition applied. This would be the mechanism for saving historical information.

4.6 Version 6

As is shown in Table 4-6, it is not particularly difficult to rectify the shortage of information contained by previous versions now that a workable basic system structure has been developed. The additional types of information included in Version 6 are based directly on the county's summary (SCPD, 1973) of its initial inventory of shoreline conditions. Each type of quantitative information tabulated on pages 16 through 19 of that document has been used to define a similar variable for inclusion in Version 6. The structure of the inventory system does require a finer spatial resolution than would have existed in Version 5; each parcel for which a data entry is made must be uniform, not only in terms of the 1/16 section in which it is located and of its data use, but also in terms of its shoreline type and two subtypes, its ownership type, and its statewide significance type. Thus, many parcels in Version 5 may necessarily be subdivided for inclusion in Version 6.

Note the much more useable form of the information provided by such a computer-based inventory system as Version 6 proposes when that system is compared with the tabulation in the county's inventory summary. Not only can one find the total miles of shoreline of each type within each municipality and the county as a whole, but one can determine the total number of miles of any combination of shoreline properties--for example, the total miles of marine, accretion, natural shorelines which are of statewide significance, are located outside of municipalities, are currently undeveloped, and are owned by small, private parties. Furthermore, he can determine the amount of this or any other type of shoreline at any given time, past or present. He also does not need to restrict his interest to the particular municipal or the total nonmunicipal region of the county; he could specify interest in one given region of the county either by a range-section-township type of designation or a basin-and-coastal-mile type of designation. Finally, he need not be content with simply discovering the total number of miles of shoreline of that type, he could order that each

Table 4-6. Information contained in Version 6.

Version 6 uses the same types of administrative, temporal location, and spatial location information as Version 5, but it includes more information on the natural character, ownership, and management designations which apply and it uses a finer spatial subdivision in order to define parcels which are uniform in these characteristics, as well as in use characteristic.

Type of Information		Data Columns Required
Administrative (as in version 5)	Person entering, correcting, or updating	2
	Date of entry, correction, or update	6
Temporal Location (as in version 5)	Date of earliest known applicability	6
	Actual date of change, or change prior to this date (A or P)	1
	Date of latest applicability	6
Spatial Location (as in version 5)	Range (03-11)	2
	Township (27-32)	2
	Section (01-36)	2
	1/16th section (01-16)	2
	Parcel number for this entry	6
	Previous parcel number(s)	12

Table 4-6 (cont.)

Spatial Location (cont.) (as in Version 5)	Basin identity	4
	River (or coastal) mile	5
	Right or left bank (R or L)	1
	Municipality (A through Z)	1
Natural Characteristics	Type (stream, lake, or marine)	1
	Subtype (estuary, pastoral, floodway, boulder, accretion, marginal, erosion, marshy delta, inapplicable)	1
	Subtype (natural, modified, inapplicable)	1
	Miles of shoreline in the parcel	4
Ownership	Ownership (small private, large private, federal, state, local, port, quasi-public, platted)	1
Use (as in Version 5)	Actual use (one of 10 types)	1
Management Designations	Shoreline of statewide significance or other shoreline (S or X)	1
		68

parcel with those properties be identified in terms of its spatial location.

Since the inventory system proposed retains the basic structure of Version 5, its updating properties would be similar. Of course, updating would be a more demanding and important program in this case because one would need to incorporate changes in ownership type, in modified versus unmodified nature, and in statewide significance as well as changes in shoreline use. However, land sales and construction or development permits issued should provide convenient monitoring points for such a routine updating program. Of course, special inventory studies could still be accommodated; indeed they would probably be necessary. Subdividing parcels which were subjected to partial changes would still be a necessity.

Of course, one would again need to provide computer programs which were designed to enter, to correct, to update, to selectively retrieve and to summarize these data. Indeed, the retrieval programs would need to be considerably more elaborate as the additional types of information were incorporated.

Version 6 clearly comes much closer to satisfying the design criteria articulated in Table 3-1 than does any of the previous versions. Although the first three criteria have not yet been explicitly considered, considerable progress has been achieved toward the others. In particular, criterion 4a regarding the availability of historical data and the possibility for shoreline assessments at any given past time is well served. So is criterion 4c regarding updating and provision of current assessments. The variable definitions used are stable (4b) and generally applicable (4d) and the system uses a very flexible system of spatial decomposition (4e). Summary statistics (4f) for virtually any spatial or temporal resolution (4g) except for lot sized breakdowns should be easily obtained. Similarly, data summaries and parcel identifiers should be obtainable for distinct combinations of shoreline properties (4h). Some of the data which are included (e.g. on natural characteristics) are clearly causative factors in shoreline development which must be considered in modeling and planning (4i). Given the concentration here on shoreline conditions data (5c), considerable progress has been made with the types of data included, although economic and cultural data are still absent and only superficial characterizations are available for other types. The orientation toward computer implementation of the inventory system (7) should provide the conveniences suggested under item (6). The system clearly is not extravagant and required expenditures should be modest (8).

The one additional item of interest with respect to the proposed system is the extent to which it would satisfy the specific types of data use identified in section 2.1. Clearly the system is most strongly oriented toward the reporting and temporal and spatial shorelines assessment needs of federal, state, county, and municipal agencies and the types of information included, while not exhausting the interests which would exist, provide a significant degree of perspective. The information included may be much less adequate, however, for considering permit issues and for satisfying the needs of individual citizens and developers; the spatial resolution provided may be too coarse and the type of information included too superficial. The amount of information on causative factors may be too little to support even broadly-scoped modeling efforts.

4.7 Version 7

The information suggested for inclusion in Version 7 (see Table 4-7) is of exactly the same types as suggested in Version 6 (natural, ownership, use, and management designations) but a special effort is made to overcome the superficiality of Version 6 and also to further develop the general applicability and the stability of the variable definitions involved. The three dimensions of natural classification identified in Version 6 have been expanded to nine dimensions in Version 7, identifying such significant properties of the area as whether it is mainland or island, whether it is protected or unprotected from wave action, and whether it is water surface, tideflats, beach, floodplain, or some other type of land feature. Similarly, ownership characteristics have been defined in terms of five different types of properties which may apply to any given piece of land rather than in terms of the one dimension which mixed these properties previously. The land use classification scheme has also been expanded by going to a second level of classification which identifies important subtypes of use for each of the major uses previously defined. Additional information on management designations including applicable environment designations and explicitly permitted uses has also been included.

The changes incorporated in this revision have several crucial properties. They provide as detailed an accounting as would probably be useful in intercounty spatial aggregations; thus, they represent a maximum level of detail at which state-wide or nationwide standardization may be desirable. They also involve a crucial consideration of variable definition generality and stability; since these definitions would be very difficult to change once counties had begun to implement the system, the definitions must certainly be very carefully

Table 4-7. Information contained in version 7

Version 7 uses the same types of administrative, temporal location, and spatial location information as Versions 5 and 6, but it includes more information on the natural character, ownership, use, and management designations which apply. It again uses a finer spatial subdivision in order to define parcels which are uniform in these more detailed characteristics.

Type of Information		Data Columns Required
Administrative (same as 5 & 6)	Person entering, correcting, or updating	2
	Date of entry, correction, or update	6
Temporal Location (same as 5 & 6)	Date of earliest known applicability	6
	Actual date of change? or change prior to this date? (A or P)	1
	Date of latest applicability	6
Spatial Location (same as Versions 5 & 6)	Range (03-11)	2
	Township (27-32)	2
	Section (01-36)	2
	1/16 section (01-16)	2
	Parcel number for this entry	6
	Previous parcel number(s)	12
	Basin identity	4
	River (or coastal) mile	5
	Right or left bank (R or L)	1
	Municipality (A through Z)	1

Table 4-7 (cont.)

Natural Characteristics	Type (shoreline, plain land)	1
	Subtype (marine shoreline, fresh shoreline, inapplicable)	1
	Subtype (mainland, island, open water)	1
	Subtype (protected, unprotected, inapplicable)	1
	Subtype (no fresh water influence, fresh influence, major fresh entrance, river, lake, stream, inapplicable)	1
	Subtype (type of river (estuary, pastoral, floodway, boulder), type of lake (f(mean annual flow through, volume, area, depth)), type of coast (accretionary, marginal, erosionary), or inapplicable)	1
	Subtype (high bank, low bank, inapplicable)	1
	Subtype (water surface, tide flats, beach, marsh, swamp, dunes, flood plain, terrace, bluff, channel banks, channel, uplands, inapplicable)	1
	Subtype (natural, modified, inapplicable)	1
	Miles of shoreline in the parcel	4
	Primary or secondary shoreline (P or S) (the primary shoreline is right at the water's edge (e.g., beach) while secondary shoreline may be back a ways (e.g., dunes). The total of primary shoreline equals the total length of the river or coast)	1
Ownership Characteristics	Type (private ownership or public)	1
	Subtype (corporate, non-profit organization, partnership, person, federal, state, county, municipal, port district, other districts, other)	1
	Type (subdivided, unsubdivided, inapplicable)	1
	Type (part of small holding, moderate holding, or large holding)	1
	Type (multiple ownerships or single)	1

Table 4-7 (cont.)

Use	Actual use (one of ten types and also the appropriate subtype from Table 2-3--48 different classes)	2
Management Designations	Shoreline of statewide significance or other shoreline? (S or X)	1
	Environment designation (e.g. urban, rural, conservancy, natural)	1
	Use explicitly permitted (same classification scheme with 48 distinct types)	2
		83

established at the outset. With such definitions well established, counties and municipalities may freely augment the characterizations with additional dimensions or levels of classification which suit their purposes and furthermore, the system has much flexibility to evolve by adding such additional dimensions at later times.

The additional detail included in this version is also particularly significant in terms of the uses the system can now serve. Modelers, permit system administrators, and citizens will find that the additional detail is helpful in their uses. Furthermore, the additional expense required to provide this detail should be nominal when compared with the greater utility it provides.

4.8 Version 8

The additional information suggested in Table 4-8 for inclusion in our expanded inventory system includes items which have been noted to be of particular importance both in the WSDOE's (1972a) guidelines for preparing inventories and as causative phenomena which are substantially involved in the types of shoreline development and use which occur. Features such as physiography, topography, views, soil, vegetation, access rights, and accessibility have been included. Shore works have been included as a cultural effect of development which is of particular interest to the WSDOE. One aspect of the additional information which merits special comment is inclusion of a coarse system of spatial coordinates based on 1/16 sections and thus of approximately quarter mile units. This new information would allow inclusion of computational programs for determining the approximate straight-line distance between two parcels or from some particularly significant location (e.g. downtown Everett or Seattle) to a particular parcel. Such a distance characteristic may be extremely significant as a causative factor in shoreline development.

Although the additional information provided may be quite helpful in program development, especially on the county and municipal levels, the main significance of the expansion is to modelers and to permit administrators. Modelers require knowledge of significant causative factors and permit administrators require details on local shoreline conditions. The additional expenditure required to achieve Version 8 should again be moderate and the data required should be relatively easy to obtain from existing maps and casual field observations.

Table 4-8. Additional information contained in version 8

Version 8 expands on Version 7 by including additional information on spatial location, natural characteristics, and ownership and some initial information on the cultural features of the region. Again, a finer spatial resolution will occur to obtain parcels which are relatively uniform in each characteristic. Since the basic structure of Version 7 will be used and all that version's information will be included, only the additional information in Version 8 will be identified here.

Type of Additional Information		Additional Data Columns Required
Administrative information will be identical to Version 7		
Temporal location information will be identical to Version 7		
Additional Spatial Location	X coordinate (001-216)	3
	Y coordinate (001-144)	3
	1 unit per 1/16 section	
Additional Natural Characteristics	Area of parcel (acres)	5
	Mean depth of water or elevation of parcel (feet)	5
	Mean slope of parcel (percent)	2
	Mean orientation of parcel	1
	View?	1
	Soil or bottom type	1
	Vegetation type	1
	Unique or fragile features	1

Table 4-8 (cont.)

Additional Ownership Characteristics	Private access to shorelines (owner, club, none)		1
	Public access to shorelines (patrons, free, none)		1

Use information will be identical to Version 7

Cultural Features	Accessibility	(miles to interstate entrance/exit)	5
		(miles to federal or state primary highway if closer)	4
		(miles to arterial street or state highway if closer)	4
		(miles to public street or road if closer)	3
	View from other parcels obstructed by cultural features on this parcel?		1
	View from this parcel obstructed by cultural features on other parcels?		1
	Shoreworks (including dredging and beach feeding)		4

Management designations will be identical to Version 7

	47
	83
(total)	130

4.9 Version 9

Table 4-9 suggests more types of information which might be included in an updatable, county inventory system; in this case emphasis is on causative factors which have received less emphasis in the WSDOE inventory guidelines (1972a). Such natural features as tide levels, river flow, mineral deposits, potential for land slides, and drainage properties may be quite important. Similarly the intensity of uses, potential for other uses, and carrying capacities for various uses are critical. A more significant addition, however, is a variety of economic and cultural features which are both effects of past development and causative factors in future development. The value of land and the types and values of its real improvements together with the numbers and types of people present and their activities are key aspects of shoreline conditions. Furthermore these aspects are principal influences on the types of people, improvements, and activities which are attracted to a given area at subsequent times.

Particularly significant as a causative factor as well is the character of adjacent parcels; thus the inclusion of information which identifies those parcels provides access to any information on their characteristics which is available within the inventory system and of interest. Note, however, that referring to adjacent parcels is demanding in the number of data-storage columns required; up to four distinct range and township combinations may be relevant and several distinct parcels within three of them could be involved. It is also demanding in terms of the involvement of a person to determine adjacentcy, especially each time a subdivision is necessary in updating.

Although information on some of these additional features may again be kept current by a routine updating procedure involving such items as building permits, many may require periodic studies or censuses for determination. Of course, special data processing programs would be needed to take advantage of the ways in which these data can be manipulated to provide additional insight. An important example of such a program would be one which could automatically examine data on adjacent parcels within the same 1/16th section to determine whether they have identical properties and thus can be combined. Given such a discovery the program might then select a new parcel number and perform the combination.

Obviously the motivation for including these causative factors within the inventory system is their relevance to modeling--to providing descriptions and predictions of what shoreline phenomena are expected to occur and why.

Table 4-9. Additional information contained in version 9

Version 9 expands on Version 8 by including additional information on spatial location, natural characteristics, use, and cultural characteristics as well as some initial information on economic characteristics. Again a finer spatial resolution will occur to obtain parcels which are relatively uniform in each characteristic. Since the basic structure of Versions 7 and 8 will be used and all their information will be included, only the additional information in Version 9 will be identified here.

Type of Additional Information		Additional Data Columns Required
Administrative information is unchanged		
Temporal location information is unchanged		
Additional Spatial Location	Census tracts (identifying number)	3
	Adjacent parcels	56
Additional Natural Characteristics	Water flow levels (mean annual)	5
	(once in 10 year minimum)	4
	(once in 10 year maximum)	7
	Tide levels (mean higher high)	4
	(once in 10 year high or similar)	4
	(mean lower low)	4
	(once in 10 year low)	4

Table 4-9 (cont.)

Additional Natural Characteristics (cont.)	Minerals	1
	Susceptability to land slides	1
	Soil/bottom transmissibility (or drainage properties)	1

Ownership information is unchanged

Additional Use Characteristics	Intensity of use (e.g. residential units per acre or recreational visitor days/acre-year)	10
	Potential uses (up to three of 48 different classes)	6
	Carrying capacity for current and any potential use	30

Economic Character	Land value (assessed, $/acre)	6
	Improvements value (assessed, $)	8
	Production (in bushels, tons, etc.)	6
	Monetary value of production (sales or surrogate)	8
	Jobs (number)	4
	(full-time equivalents)	5
	Employee earnings ($/fte-year)	5

Table 4-9 (cont.)

Additional Cultural Features	Water traffic generated (units/year)	5
	Historic importance	1
	Number of businesses	3
	Number of housing units	4
	Public accommodations (units)	4
	Recreation facilities	5
	Population (residents)	4
	Per capita income ($/resident)	4

Management designation information will be unchanged

	211
	130
(total)	341

Even though these data are now being suggested on a relatively fine spatial scale, they are also relevant to broad-scale modeling; when broad-scale modeling uses broad-scale data, those data must be aggregated from finer data if they are really to constitute measured characterizations of the world. Furthermore, the finer data are useful in their own right for both fine-scale modeling (prediction of any sort) and as an information base in administering the permit system.

4.10 Version 10

Table 4-10 presents yet another expansion on the range of information which might be included in the inventory system. Spatial location might be augmented with latitude and longitude and natural characteristics such as water quality and geology might be included. Climatological data has been conspicuously absent from previous versions and it certainly is a significant causative factor in shoreline development. It is important, however, that one would want to limit the temporal detail with which such data were included in the particular form of inventory being discussed here. Long-term averages and probabilities of extreme occurrences would be the factors of interest in shoreline development and those figures might be updated only every five years or so. Again, modeling and the permit system would be the primary uses which such additional information would serve.

It is useful to again assess the ways in which the proposed inventory system is adequate or inadequate relative to the criteria that have been given in Table 3-1. The expansions of the system suggested in both Version 9 and Version 10 have been particularly oriented toward the idea of serving all, or at least most, of the data needs relative to the shorelines of the county (criterion 1). In particular the modeling and permit-system-operation needs have been of specific concern and have led to a greater inclusion of causative factors (4i) which include economic and cultural factors (5c). In this expanding mode, however, the need for coordination or possible merging with other data programs (3) becomes more and more relevant. Indeed, not only does interaction with other data programs become relevant, it may be that the data system itself should be viewed as one which would include all data gathering relative to temporal and spatial phenomena within the county--data that might be used for any purpose--rather than limiting the system to shoreline data for use in shoreline management (Betchart, 1974). This would be a considerable revision of criterion 1. Such a change in scope may also be required to justify the additional expense (criterion 8) which would be involved in continuing inventory system expansion. This may be appropriate, however, since economic and cultural data would obviously be useful in activities other than shoreline management.

Table 4-10. Additional information contained in version 10

Version 10 is an expansion of Version 9. The same expansion comments apply and the same strategy of presentation is used.

ype of dditional nformation		Additional Data Columns Required
Administrative information is unchanged		
Temporal location information is unchanged		
Additional Spatial Location	Latitude (degrees/minutes/seconds) of parcel centroid	6
	Longitude (degrees/minutes/seconds) of parcel centroid	7
Additional Natural Characteristic	Water quality	4
	Distance to surface water	5
	Depth to fresh groundwater	4
	Depth to bedrock	3
	Geology	4

Table 4-10 (cont.)

Additional Natural Characteristics (cont.)	Soil/bottom/water fertility	4
	Precipitation (mean annual)	4
	(once in 10 year minimum)	4
	(once in 10 year maximum)	4
	Snowfall (mean annual)	3
	(once in 10 year minimum)	3
	(once in 10 year maximum)	3
	Solar radiation (mean annual)	3
	(once in 10 year minimum)	3
	(once in 10 year maximum)	3
	Temperature (winter mean)	4
	(summer mean)	4
	(once in 10 year low)	4
	(once in 10 year high)	4
	Winds (directions)	6
	(velocity typical)	3
	(velocity once in 10 year high)	3
	Animal types	1
Additional Ownership Characteristics	Less than fee interests	4
	Leases	2

Use information is unchanged

Table 4-10 (cont.)

Additional Economic Characteristics	Property tax rate	4
	Sales taxes generated ($/year)	6
Additional Cultural Features	People per family	3
	Other socio-economic and ethnic data	15
	Percent impervious area	2
	Percent directly connected impervious area	2
Additional Management Designations	Zoning designation	3
	Other planned uses	6
		143
		341
		484

4.11 Version 11

Through the sequence of expansions which has been identified, it becomes obvious that the total storage capacity of the information systems being proposed is increasing rapidly. Not only is more information being included in every entry, however. Each additional variable may require a further spatial breakdown which leads to more entries and thus the repetition of all the other information relevant to the parcels which must be subdivided. Furthermore, each additional variable incorporates one more item that can change and require an update, thus more updates will be required and all the unchanged data will have to be repeated with each update. This situation is bound to eventually require a search for a more efficient storage structure and Version 11, which is presented in Table 4-11, incorporates such an improvement.

The key innovation in this new version is definition of two types of data entries, one which includes only those items of information which apply to whole 1/16 sections throughout the county and the other which includes information which may vary spatially within a 1/16 section and which is given with respect to homogeneous parcels within 1/16 sections. Thus, for any particular 1/16 section there will be one entry of Type A and possibly several of Type B. One therefore does not have to repeat the Type A information for each parcel. Furthermore, it may be that the Type A information will need to be updated less frequently than the Type B information and efficiency can be gained in this way as well. This is very obviously the case with the information contained in Version 11.

The information which is contained by this suggested version is identical to that contained by Version 10. Thus it will serve exactly the same uses and will satisfy most of the criteria to the same extent. It will require a more intricate collection of data retrieving, processing, and summarizing programs, but this additional cost should be more than offset by savings in storage costs.

4.12 Version 12

Table 4-12 takes the idea of a comprehensive, general-purpose information system to an expanded stage of development both by incorporating more types of information which are of interest in, if not directly identified with, shoreline management and by consuming the two other information systems which exist in Snohomish County--the urban systems engineering data base (Systems Control, Inc. et al., 1973) and the assessor's data-base. In order to do so it would be necessary for the inventory system

Table 4-11. Information content and structure of version 11.

Version 11 contains exactly the same information as Version 10, but adopts a more efficient information system structure.

Type of Information			Columns Required
	Entry Type A		
Administrative Information	Entry type (A or B)		1
	Person entering, correcting, or updating		2
	Date of entry, correction, or update		6
Temporal Location	Date of earliest known applicability		6
	Actual date of change or change prior to this date? (A or P)		1
	Date of latest applicability		6
Spatial Location	Range (03-11)		2
	Township (27-32)		2
	Section (01-36)		2
	1/16 section (01-16)		2
Natural Characteristics	Water quality		4
	Water flow levels	(mean annual)	5
		(once in 10 year minimum)	4
		(once in 10 year maximum)	7
	Tide levels	(mean higher high)	4
		(once in 10 year high or similar)	4
		(mean lower low)	4
		(once in 10 year low or similar)	4

Table 4-11 (cont.)

Natural Characteristics	Precipitation	(mean annual)	4
		(once in 10 year minimum)	4
		(once in 10 year maximum)	4
	Snow fall	(mean annual)	3
		(once in 10 year minimum)	3
		(once in 10 year maximum)	3
	Solar radiation	(mean annual)	3
		(once in 10 year minimum)	3
		(once in 10 year maximum)	3
	Temperature	(winter mean)	4
		(summer mean)	4
		(once in 10 year low)	4
		(once in 10 year high)	4
	Winds	(directions)	6
		(typical velocity)	3
		(velocity once in 10 year high)	3
Economic Characteristics	Property tax rate		4
	Sales taxes generated		6
Cultural Features	Population (residents)		5
	Per capita income ($/resident)		4
	People per family		3
	Other socio-economic and ethnic data		15

Entry Type B

Administrative Information	Entry type	1
	Person entering	2
	Date of entry, correction, or update	6

Table 4-11 (cont.)

Temporal Location	Date of earliest known applicability	6
	Actual date of change or change prior to this date? (A or P)	1
	Date of latest applicability	6
Spatial Location	Range (03-11)	2
	Township (27-32)	2
	Section (01-36)	2
	1/16 section (01-16)	2
	Parcel number for this entry	6
	Previous parcel number(s)	12
	X coordinate (001-216) 1 unit per 1/16 section	3
	Y coordinate (001-144)	3
	Latitude of parcel centroid (degrees/minutes/seconds)	6
	Longitude of parcel centroid (degrees/minutes/seconds)	7
	Basin identity	4
	River (or coastal) mile	5
	Right or left bank (R or L)	1
	Municipality (A through Z)	1
	Census tract	3
	Adjacent parcels	56
Natural Characteristics	Type (shoreline, plain land)	1
	Subtype (marine shoreline, fresh shoreline, inapplicable)	1
	Subtype (mainland, island, open water)	1
	Subtype (protected, unprotected, inapplicable)	1

Table 4-11 (cont.)

Natural Characteristics	Subtype (no fresh water influence, fresh influence, major fresh entrance, river, lake, stream, inapplicable)	1
	Subtype (type of river (estuary, pastoral, flooding, boulder), type of lake (f (mean annual flow through, volume, area, depth), type of coast (accretionary, marginal, erosionary), or inapplicable)	1
	Subtype (high bank, low bank, inapplicable)	1
	Subtype (water surface, tide flats, beach, marsh, swamp, dunes, flood plain, terrace, bluff, channel banks, channel, uplands, inapplicable)	1
	Subtype (natural, modified, in applicable)	1
	Miles of shoreline in the parcel	4
	Primary or secondary shoreline (P or S)	1
	Area of parcel (acres)	5
	Mean depth of water or elevation of parcel (feet)	5
	Mean slope of parcel (percent)	2
	Mean orientation of parcel	1
	View?	1
	Distance to surface water	5
	Depth to fresh ground water	4
	Depth to bedrock	3
	Geology	4
	Minerals	1
	Susceptability to land slides	1
	Soil/bottom type	1
	Soil/bottom transmissibility (or drainage properties)	1

Table 4-11 (cont.)

Natural Characteristics	Soil/bottom/water fertility	4
	Vegetation type	1
	Animal types	1
	Unique or fragile features	1
Ownership Characteristics	Type (private ownership or public)	1
	Subtype (corporate, non-profit organization, partnership, person, federal, state, county, municipal, port district, other districts, other)	1
	Type (subdivided, unsubdivided, inapplicable)	1
	Type (part of small holding, moderate holding, or large holding)	1
	Type (multiple ownerships or single)	1
	Private access to shorelines (owner, club, none)	1
	Public access to shorelines (partons, free, none)	11
	Less than fee interests	4
	Leases	2
Use Characteristics	Actual use (one of 48 different classes)	2
	Intensity of use	10
	Potential uses (up to three of 48 classes)	6
	Carrying capacity for current and any potential use	30

Table 4-11 (cont.)

Economic Characteristics	Land value (assessed, $/acre	6
	Improvements value (assessed, $)	8
	Production (in bushels, tons, etc.)	6
	Monetary value of production (sales or surrogate)	8
	Jobs (number)	4
	(full-time equivalents)	4
	Employee earnings ($/fte-year)	5
Cultural Characteristics	Accessibility (miles to interstate entrance/exit)	5
	Accessibility (miles to federal or state primary highway if closer)	4
	Accessibility (miles to arterial street or state highway if closer)	4
	Accessibility (miles to public street or road if closer)	3
	View from other parcels obstructed by cultural features on this parcel?	1
	View from this parcel obstructed by cultural features on other parcels?	1
	Shoreworks (including dredging and beach feeding)	4
	Water traffic generated (units/year)	5
	Historic importance	1
	Number of businesses	3
	Number of housing units	4
	Public accommodation (units)	4
	Recreation facilities	5
	Percent impervious area	2
	Percent directly connected impervious area	2

Table 4-11 (cont.)

Management Designations	Shoreline of statewide significance or other shoreline? (S or X)	1
	Environment designation	1
	Use explicitly permitted	2
	Zoning designation	3
	Other planned uses	6
		516

Table 4-12. Additional Information Contained in Version 12. Version 12 is an expansion of Version 11. It might be characterized as the "additional-possibilities version" and is presented in that light. One such possibility is a finer geographic resolution--one which treats each lot individually in conjunction with a computer plotting capability. Obviously this is not immediately realistic. The additional possibilities are simply listed according to information type.

Type of Additional Information		Additional Data Columns Required
Additional Spatial Location	Washington State coordinates	13
	Street addresses	20
	Assessor's numbers	10
	Legal description	1000
	Depth below surface	5
Additional Natural Characteristics	Susceptibility to volcanoes	1
	Susceptibility to earthquakes	1
Additional Ownership Characteristics	Owner's names	20
Additional Cultural Features	Power use	5
	Public water supply district	1
	Water pressure zone	1
	Water metering?	1
	Water use	6
	Sewer district	1
	Wastewater generation	10

Table 4-12 (cont.)

Additional Cultural Features (cont.)	Solid waste generation	3
	School district	1
	Legislative districts	2
	Voter information	10
		1111
		516
		1627

to go to a lot by lot geographic resolution. A further refinement which might be included would be inclusion of a precise description of lot boundaries with an associated computer based plotting capability. Such a features is clearly just a dream at this stage, however. Thus Version 12 might suitably be called the "additional possibilities" version of the inventory system--simply a recording of the ideas which have entered the designer's mind, however briefly. Inclusion of all these features would clearly be very expensive, and thus each would have to be firmly justified with a view toward some data use or uses, even if those uses were not related to shoreline management. To make such a data system feasible, one might well have to incorporate several storage-structure innovations of the type suggested in Version 11.

5 Summary

Based ultimately on a group of potential data uses which was identified in section 2.1, and subsequently on the idea of describing relevant aspects of the real world with a convenient and technologically feasibly inventory system, several different possible versions of such a system have been identified. Each has been identified primarily by the data which it would contain. Although each would include information on the shoreline management policies within the basin and on the actions taken within the shoreline development permit system, a wide range of variation among potential systems exists based on the descriptions of shoreline conditions which might be incorporated. The alternatives developed here cover most of that range. Very simple systems which are clearly inadequate are identified; at least one system which is clearly beyond immediate reach is identified; and several other, intermediate systems are outlined.

One interesting aspect of this range of alternatives is the different data storage structures which they incorporate. The simplest systems were found to be cumbersome until an elementary structure (Version 5) was obtained which facilitated development of the data base in spite of dramatic spatial variability, facilitated storage of historical information, and facilitated updating. The concept of a parcel which could be described as homogeneous in all the properties considered by the inventory system was the cornerstone of this structure. A further development in basic data program structure was found to be potentially important in Version 11 where two different levels of spatial homogeniety were incorporated.

Updating is, in itself, an exceptionally interesting aspect of the inventory system. Two different means of updating could occur. One would depend on information from such things as building permit or shoreline development permit approvals, zoning changes, and recording of deeds. The inventory system would then include a procedure for routinely recording those changes as each official action was completed. The other updating technique would be a program of periodic surveys such as censuses or ecological studies which would then result in special updated information to reflect conditions at that time. The inventory systems which appear to be the most attractive combinations of useful data and reasonable expense would rely on both updating methods.

The series of different inventory systems would require very different computer programs to accomplish the needed interaction with the data base. Generally the programs would be much more intricate as one progressed to a more comprehensive data program.

In each case, however, special programs would be required to input information to the data base as original entries, corrections, or updates and to obtain outputs from the data base in the form of data listings, data summaries, or a time series of some particular variable or summary variable. Thus, six standard types of program components would be needed. In addition, special programs might be added to perform computations of properties which could be derived from the data base--for example, the distance of a parcel from Seattle. Another special program would be required to compute a new parcel number when subdivisions or mergers were to occur, and still another program would be required to plot parcel boundaries on the basis of legal descriptions or to determine which parcels were adjacent to newly defined parcels. Of course, this last type of program would be needed only in Version 12.

Obviously, one has a wide range of choice in developing an inventory system and it is critical to choose wisely.

6 Conclusions

In choosing a direction for inventory system development some aspects do deserve more emphasis than others.

1) The purpose of the inventory system--that is, the uses to which the data are to be put--should be the fundamental consideration in design.

2) In the present case, where those uses are visualized to include shoreline management program planning on the state and county levels and also administration of the shoreline development permit system, it is extremely important that data be available on the policies which are relevant to the different local jurisdictions and on past action within the permit system, as well as on shoreline conditions.

3) In developing an inventory system design, there appear to be three different types of critical decisions: a) variable definition decisions; b) information inclusion decisions; and c) information structure decisions.

4) Of these the variable definition decisions appear to be least amenable to evolution; when one redefines a variable it usually means that information on that variable must be developed from scratch. Thus, it is most critical that variable definitions be well established before prototype or system implementation.

5) It is important to choose a design which can evolve, indeed development of an inventory system on an evolving basis is an important practical strategy in itself. It is also important, however, to achieve a "state-of-the-art" system in as few iterations as is practical, since much effort in data development and computer program development must be repeated in each iteration. One would therefore prefer two or three iterations to five or six.

6) The basic structural decision made here was to use a particular data entry to record properties of a given region which existed throughout a given period of time. If any one property changed, then a whole new entry would be created describing the region's properties for a new time period. If some spatial variation in a property were significant, then new entries would be created for homogeneous subregions during the time period.

7) As more comprehensive collections of characteristics are described, it appears efficients to identify different levels of spatial and temporal homogeity. For example, one might identify four different types of data entries:

   a) Properties which were time invariant and which could always be attributed to a whole 1/16 section.

   b) Properties which could always be attributed to a whole 1/16 section but were time variable (needed updating).

   c) Properties which were time invariant and which could be used to subdivide the 1/16 sections into homogeneous parcels with constant spatial boundaries.

   d) Other properties which were time variable and which required further subdivision of the region into homogeneous parcels with time variable boundaries.

   Such a structure could be even further developed by using a number of different spatial and temporal resolutions as bases for defining more types of data entries.

8) The wide variety of spatial resolutions which are of interest in shoreline management and which the county inventory system must serve is especially significant in shoreline management. It is for that reason that data on a fine spatial resolution which can be aggregated on any temporal or spatial basis which is desired seem to be ideal in this inventory system.

9) In addition to their relevance in uses with small spatial scopes, data with a fine spatial resolution are often the necessary building blocks in developing the broad-scale data needed in broader scoped uses. In shoreline phenomena the man-induced and natural spatial variability should lead one to be very skeptical of spatial sampling with subsequent inference of broad characteristics. Aggregation from finer data is the only other alternative. The fine-resolution, spatial data may thus be critical to broad-scoped uses as well.

10) The indicated relevance of data on other phenomena to shoreline management, the ease with which other data can be incorporated into the inventory system when various levels of spatial and temporal resolution

are used, and the flexibility then available in aggregating these data points strongly to consideration of a single "county data program" which would include essentially any type of data that needed to be reported relative to the spatial and temporal sector of the real world which it described. The suggested designs show a capability for evolving into such a system.

11) In spite of the explicit desire to design inventory systems which were primarily oriented toward serving data uses, the discussion of data use (section 2.1) is undoubtedly the most superficial part of this document.

12) Much work therefore remains in achieving an acceptable inventory system design.

7 Recommendations

Several specific steps which would further the design are obvious. Indeed they are critical in light of the observations and the shortcomings of this working paper.

1) A concerted effort is needed to more explicitly and precisely identify the exact uses (relative to each user) which must be served. Furthermore the exact ways in which the data should serve each of these uses should be identified. For example, how would state planners use shoreline data in policy discussions and program planning and development? What is the more specific form of the model which modelers would most like to establish and what cause-effect phenomena must it represent? Answers to questions such as these will then lead to more definite indications of the types and quanitities of data which should be included.

2) A concerted effort is needed to more solidly define the variables to be used in the data program--for example, the scheme for classifying land use. Only then will the inventory system(s) eventually developed to a prototype stage be attractive to a large group of state and county agencies and only then can they lead to the type of standardization which is needed if data aggregation and comparison are to be possible.

3) These efforts must include intensive interaction with state and local planners and permit administrators. Perhaps this paper or an abbreviated version of it can serve as a basis for such discussions.

4) Several alternative systems might then be selected for prototype development. This writer believes that Version 7 is the simplest version which warrants such effort. Versions 8, 9 and 11 are others which deserve consideration. Prototypes should be initially demonstrated on a very small (2 to 5 square miles) spatial example to provide efficiency in system development. The Tulalip Bay area and the Edmonds area deserve consideration.

5) Prototype development should be specifically oriented toward consideration of a) data use, b) variable definition, c) operating convenience, d) technical feasibility, and e) economic feasibility.

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