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A Summary of Processes Affecting Archeological Sites in Artificial Reservoirs

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ABSTRACT

Site inundation dynamics are examined through a comparison of the processes affecting submerged and intermittently submerged sites in artificial reservoirs. To enhance the limited data base, an experimental design involving the quantification of features and artifact displacement is proposed.

INTRODUCTION

Cultural resource management is increasingly involved with the evaluation of sites tied to either future or existing reservoirs. As the number of reservoirs increase, so do the number of sites impacted by their construction or existence. Reservoirs present a complex set of circumstances effecting archeological resources. All levels are impacted: the macro- or regional scale, the meso- or site scale, and the micro- or artifact scale.

The premier study to date is the National Reservoir Inundation Study (NRIS) conducted by National Park Service personnel in the late 1970s. This report is primarily a summary of their findings, as well as an attempt to make the results regionally significant.

THE NRIS STUDY

Beginning in 1976, the National Park Service instituted the NRIS (Lenihan et al. 1981). The project was geared towards better understanding how to best manage inundated archeological resources (Lenihan et al. 1981:v). Two problems were addressed: first, the prediction of effects from impending inundation on existing archeological resources, and, second, the mitigation of those situations (Lenihan et al. 1981:17). Four categories of impact were recognized. The first was mechanical, which includes the "physical erosion and depositional processes associated with any large body of water." The biochemical factors require examining the new ecosystem formed after initial filling. Human factors include increased artificial impacts on archeological resources, both directly, through greater access, and indirectly, through an increase in wave action caused by boat traffic. Various miscellaneous factors are also included, such as changes in the floral and faunal components of a location, and the resource may be lost to research through inundation or submergence below silt deposits (Lenihan et al. 1981:18-19).

These factors combine to produce a wide array of situations that must be considered when examining a reservoir, whether potential or existing. The NRIS considered impacts at three different levels of archeological resources, loosely categorized in the macro-, meso- and micro-scales. In short, four types of processes are operating on three levels of resources. The biochemical processes are most important during initial filling, as an equilibrium is soon established, barring major changes in other variables. The biological community is obviously vastly altered, as terrestrial communities are supplanted by aquatic ones. Chemical processes are evident as water reacts with substrates; however, these too become stabilized in time. The miscellaneous and human-induced factors are difficult to control. Of primary importance to the majority of extant reservoirs are the mechanical processes.

These consist primarily of wave action and current, erosion, and sedimentation.

MECHANICAL PROCESSES

These processes include the effects of waves and their by-products, currents. Also of importance is slope failure or slumping, saturation of lake bed deposits, and siltation (Lenihan et al. 1981:18). The most drastic of these impacts is wave action and current at the lake/shore interface

Regional Impacts

The long-term effect of a man-made reservoir is that it will eventually fill completely with sediment, and thus become a vast floodplain (Lenihan et al. 1981:82). Archeological sites once accessible will be buried under tons of overburden, effectively sealing them from any additional research. They will be lost as surely as if they had been destroyed. In a system of lakes, as seen along the Colorado River in Central Texas, inundation will create an entirely new dynamic, reconfiguring the entire basin from pre-dam conditions. This will have profound effects on interpreting sites that may be re-exposed during periods of low water, with concomitant loss of information regarding settlement patterning and land and resource use.

Site Impacts

There are four main variables that will determine the extent of impacts to sites in reservoirs (Lenihan et al. 1981:91-92). One variable is the make up of the reservoir. Its area, its depth, the type of watershed it is in, its orientation, and climatic variation all combine to produce differing effects. Next it must be considered where in the reservoir the site is located. Sites at the shoreline will receive more wave impact. Sites in deeper water will be subject to greater siltation. Another factor is the geologic and environmental history of the site. Sites on unconsolidated material will be subject to greater erosive forces. Slope, orientation, and types of vegetation will also be factors. Finally, the type of site and types of features in sites will be differentially more able to withstand destructive forces. For instance, it is hypothesized that the pavement of a basin hearth will be more stable than a simple surface-laid ring hearth (Malof 1996:72).

Artifact Impacts

Artifact impacts are dependent upon the class of artifact. Perhaps most important is the effect of wet-dry cycling upon various types of artifacts (Lenihan et al. 1981:143). Ceramics, bone, pollen, and shell are all affected to varying degrees. Lithics, although not directly subject to chemical or physical changes due to wet-dry cycling, may often have their attributes altered. Use wear may be obscured, or even produced, by movement through and across ground surfaces (Will and Clark 1996:514). Mechanical impacts on artifacts are therefore most pronounced at the fluctuating shoreline.

BIOCHEMICAL PROCESSES

Biologically, the previously terrestrial ecosystem becomes aquatic (Lenihan et al. 1981:19). This can include micro- and macro-faunal and floral changes. Chemical changes are induced as well, as water is superimposed and mixed with existing strata.

Regional Impacts

The main concern is that the environment will be completely changed. The result is that unless a full physical and biological inventory is performed before inundation, the comparative and physical data base commonly used to reconstruct ancient geomorphology and plant and animal communities will be lost.

Site Impacts

Biochemical impacts are discriminatory in their effects, and impact soil chemistry and stratigraphy (Lenihan et al. 1981:117). Elemental concerns are primarily carbon, nitrogen, phosphorous, sulfur, and calcium. It is well known, for example, that concentrations of phosphorous can be an indicator of living surfaces, as it is the by-product of organic waste materials, and when found in large concentrations indicates human refuse. When soils are inundated, leaching and redistribution of phosphates can occur, with the resulting loss of associated information. It is interesting, however, that carbon remains suitable for C14 dating, as charcoal does not appear to be tremendously affected by inundation (Lenihan et al. 1981:179). Other organic remains, though, are subject to destructive microbial action until an equilibrium is reached, often when anaerobic conditions begin to prevail.

Artifact Impacts

Impacts to artifacts are also class-dependent, and further complicating matters is the environment within which they are found (Lenihan et al. 1981:147). Bone, for instance, may dissolve in acidic conditions often found in anaerobic environments. Wood, seed, and pollen are all variably affected by the chemical constituents of their respective matrices. In general, alkaline conditions are more conducive to preservation than acidic conditions. Ceramics appear to reach an equilibrium, with the most obvious effects being pitting and fading of pigment. Low-fired ceramics may dissolve completely, while hard-fired ceramics maintain a great degree of integrity. Lithics, not surprisingly, show little evidence of change due to biochemical processes. Presently unknown, however, is the potential for changes in trace element composition. The NRIS study was limited to a 20 year sample. Personal observations indicate some lithics may take on a distinctive orange and black patina in a 50 year reservoir, but that evidence is not conclusive, as there was no comparative sample.

HUMAN PROCESSES

The primary impact is related to the increased access to archeological sites (Lenihan et al. 1981:19). This can be a direct impact, through land use and collecting, or indirect, as in the result of increased wave action due to boat wakes.

Regional Impacts

These impacts can be relegated almost entirely to the same category as physical impacts. Human-induced perturbations produce the same types of disruptions. Increased wave action disrupts sites, as does intentional and non-intentional disruption of sites. Loss of site information leads to the loss of regional archeological information.

Site Impacts

These again range from the obvious looting or collecting at sites, disruption of features for fire rings or other, more esoteric uses, to changes in land use patterns (Lenihan et al. 1981:130). Once remote areas may now be used for all terrain vehicles, hiking or biking trails, or camp sites. Many of these activities can adversely affect sites.

Artifact Impacts

Selective collection of artifacts is the most obvious impact (Lenihan et al. 1981:173). Once collected, they are gone from the record, and associative information is lost. Pollution may effect chemical values of soil matrices, and so also differentially affect preservation and dating.

MISCELLANEOUS PROCESSES

These are described as a multitude of impacts, from new floral successional regimes, changes in faunal habits, and loss of site accessibility (Lenihan et al. 1981:19). These are primarily a combination and function of the other factors under consideration.

Regional Impacts

Again, these impacts are related to site destruction. Once the site has been altered, it can no longer be easily incorporated into the larger regional outlook.

Site Impacts

One example is the introduction of mussels to newly inundated sites (Lenihan et al. 1981:133). When water levels recede, these exposed mussel beds are raided by raccoons, who create extensive damage burrowing for this food source. The burrowing of the mussels themselves may create mixing in subsurface deposits. Other problems occur with new successions of plant species. Salt cedar can establish itself in shallow water, and completely cover or destroy sites (Lenihan et al. 1981:136). These all create problems in interpreting the archeological record.

Artifact Impacts

Artifacts in freshly exposed soils are subject to a variety of faunal impacts (Lenihan et al. 1981:174). They may be damaged by cattle, or burrowing animals may dislodge and damage them. Rodents are known to gnaw on bone and antler. Loss of vegetation due to submergence allows the redistribution of artifacts and features. Encroaching invasive species may alter soil profiles, and contribute to the disruption of artifact context and associations.

MITIGATION CONCERNS

Ideally, a reservoir will be inventoried prior to its filling. Sites will be recorded during survey, and assessed for intact stratigraphy, diagnostics, and other indicators of research potential for information on prehistoric or historic lifeways. Added to these assessments should be the long-term preservation potential for the individual site. For instance, in the case of Lake Limestone in East Central Texas, out of 62 sites, 11 were chosen for excavation (Mallouf 1979). These sites were located exclusively in the deep water river channel in areas (with one exception) of low impact potential. The exception was located at the upstream side of the dam base, where construction activities would have destroyed the site. The sites chosen for excavation, however, were all located along the edges of the pre-dam river bed, and contained considerable archeological information. This selection process, surely a painful one, meant that many sites located on the edges of the soon-to-be reservoir were not excavated, and therefore were subject to more intense processes of mechanical impacts. The issue is complicated: should priority be given to excavate sites that are to become relatively stable over those with possibly a lower information potential, but subject to greater degradation? If preservation is factored into the equation, these choices may become easier.

Once a reservoir is established, which many were prior to the enactment of antiquities laws, it must be realized that a certain amount of damage has been done. That information destroyed or skewed by inundation must be taken into account by the archeologist. In many cases, where reservoirs are subject to fluctuating levels, sites are documented or re-documented during periods of low water. Some of these may be exposed for the first time in years, and it is vital that the archeologist recognize the possible impacts upon them.

The most important processes affecting sites in fluctuating water basins are the mechanical. One is left with the problem of determining how much of the site has been left intact. In some cases, it appears that previously unrecognized features are now eroding out of new cut banks. At the Grelle site (41BT1) in Burnet County, during a recent low water event, a number of hearths were seen on the river's edge (Lower Colorado River Authority [LCRA] 1998). The site had been extensively excavated in the 1930s. These hearths were therefore a new addition to the record of the site. This same low water event exposed new features at 41TV1794, also along the Colorado River (LCRA 1998), and a series of surface hearths and middens at 41TV209, at the south end of Lake Travis (Malof 1996). Or did it? Etchieson and Couzzourt (1987:8-10) noted that dissolution of underlying strata combined with erosion created "new" features at Lake Meredith in the Texas panhandle. In a 50 year reservoir such as Lake Travis, it is entirely possible that varied rates of deflation have caused deposits from dissimilar deposits to collapse to a common plane, whereupon they are subsequently reburied under sediment, only to become re-exposed, providing the appearance of an intact feature.

Only through experimental and experiential research will this equation be clarified. This can be accomplished through several means. Will and Clark (1996) conducted an experiment in Maine where they produced an artifact assemblage and placed it upon the fluctuating bank of a natural lake. They determined that artifacts would redistribute themselves, typically upslope and in the direction of current forces (Will and Clark 1996:515). They noted artifacts tended to cluster around more permanent fixtures, namely large embedded stones, and created the illusion of new artifact clusters (Will and Clark 1996:516). Smaller artifacts, such as flakes, became entirely displaced, and further skewed the record (e.g., Lenihan et al. 1981:113). Unfortunately, dynamics affecting sites and assemblages are as varied as site locations, resulting in an almost infinite number of variables. It is for this reason that experimental designs should be implemented with as much frequency as possible. For instance, the Maine experiment involved an established natural lake subject to icing some five months of the year. The lake bed was formed of gravels and cobbles (Will and Clark 1996:511). This is dramatically different from typical conditions in Central Texas, for instance, where icing is virtually nonexistent, and shorelines tend to be formed of deep alluvial deposits.

This site-specific set of circumstances requires differing sets of research parameters. Ideally, a separate data base would be available for each site location. This is obviously not possible. In lieu of this complete data base, a partial one must be established. As it grows, more information will be available for a variety of site locations.

Some of this work has already begun. At 41BT305, on the shore of Lake Buchanan, a part of the Colorado River chain of highland lakes, a representative selection of exposed hearths has been carefully mapped by a transit (LCRA 1998). Although Lake Buchanan is not normally subjected to wide fluctuations in water level, the study area is on a low enough slope to enable exposure at minor variations. When these features are once again exposed, they can be remapped, and any movement will be documented. Similarly at 41TV209, on the southern portion of Lake Travis, also part of the Colorado River chain of lakes, a series of hearth features has been drawn, photographed, and tied to a central datum (Malof 1996). Re-exposure will add information to sites situated in similar topographic surroundings.

Site documentation in similar circumstances should include these types of data, so as to quantify feature and artifact movement through time. Realistically, it is seldom that minor sites receive this type of long-term attention, but if priorities are shifted, valuable information may be gained that can be applied to more significant archeological sites.

SUMMARY

The processes affecting submerged sites are variable and complex. Mitigation includes recognizing factors affecting soon-to-be submerged sites, recently exposed sites, as well as long submerged sites. These factors include all levels of the archeological record. Regional settlement pattern studies are affected by site preservation, and site interpretation is affected by artifact preservation. Differential preservation on one level affects the systemic interpretation of all others. In order for such sites to be fully understood, a regional data base must be established. This will only be accomplished through experimental design and careful documentation of existing sites. Publishing such efforts may help to substantially increase the amount of knowledge to be gained from otherwise disturbed sites, and therefore add significantly to the archeological resource base.

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