

Chapter 2

A Dynamic Processual Maritime Archaeological Landscape Formation Model

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Introduction

Human behavior and its resultant material remains exist on a physical and cultural landscape and cannot be separated from it. Studying archaeological sites within the landscape reveals patterns of human behavior that can only be identified within that context. At the same time, it is imperative to consider the environmental regime and human interactions with and within it; otherwise, it is impossible to fully understand the maritime landscape and associated human behaviors.

The shipwreck and its archaeological site are components of the narrative of human behavior on the maritime archaeological landscape. The natural environment in turn constrains and informs human behavior and plays a large and important role in the development of maritime culture and the maritime landscape. The processes by which this occurs can be studied through analysis of the archaeological record. This chapter integrates the components of the maritime landscape with the understanding of the archaeological and historic records as well as oceanographic processes to develop a model that takes into account not only shipwrecks but all archaeological remains in a region. While the maritime cultural and archaeological landscape incorporates all behaviors, beliefs, activities, and physical and social constructs oriented socially and spatially toward maritimity, this chapter specifically focuses on the landscape of maritime disasters—how the cultural and physical environment influences wrecking events—to show the proposed model's efficacy. This is subsequently illustrated by the example of spatial and temporal patterning of shipwreck events in and around Thunder Bay in northern Lake Huron in the nineteenth and early twentieth centuries.

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Maritime Cultural and Archaeological Landscapes

A true archaeological landscape cannot be fully defined materially, but has to be understood as a both physical and cognitive social, spatial, and temporal construct of what is physically present and what those who live within and those who study it perceive. As it will be shown, this does not mean that the landscape cannot be studied scientifically; rather it informs a more robust empirical understanding of human behavior and its relationship with the natural world.

Traditionally, archaeologists have viewed the landscape in one of two ways: as a physical phenomenon of human construction focusing on the human–land relationship in economic terms, or as a subject, reconstructing snapshots of historical elements (Darvill 1999:105). Darvill (1999:108–110) states that these approaches necessarily overemphasize the built landscape that can be experienced visually. They also assume that the landscape is essentially stable in at least the short term. He recommends considering the landscape as a socially imposed conception of space, time, and social action on what is perceived to be the natural and social world. The partitioning of space and time can be physical or cognitive, defined through attributed meaning. Social action is different from general behavior as it must be collectively intentional. In other words, society structures landscape.

Westerdahl (1998) identifies two fundamentally important socially constructed physical components of the maritime landscape: transport zones and maritime technology. Transport zones are enduring or traditional zones of transport geography. They require community consent and cognitive recognition for their existence. They exist in physical space yet their parameters of use are structured socially. Two parts to their understanding are long-term perspective where transport zones have associated direction (vector) attributes and their cultural, environmental, and technological restrictions of use such as transport techniques, climatic adaptation, seasonal variations, anthropogenic factors such as technology use-skill, etc. For example, a zone may not exist during the period of time in which it is iced over, but exist with the appearance of icebreakers. Shipping accidents often occur when activity operates outside of transport zone boundaries or when the attributes of transport zones are altered, such as during violent storms. Zone identification can vary depending on spatial scale of analysis; they can split and reform in response to outside forces; they can be temporary or periodic; and the loci of transfer between zones can be dangerous, often the location of several wrecking events, the consequences of non-uniform change on the landscape.

A second category of maritime transportation zones can be patterned onto the above physical transportation zones: the duality of danger versus safe zones (Duncan 2004). Both danger and safe zones have physical and cognitive definitions, and identification varies according to the same parameters as the physical transport zones; however, what sets them apart from the fundamental zone types is the fact that their physical and cognitive identifications can often be in opposition to one another.

The significance of maritime technology is that it is assumed to be adapted to the transport zones in which it is being operated. It is also dependent on peripheral social factors such as risk recognition and responsive behavior. The combination of the two components allows for a landscape approach to maritime behavior incorporating both the social and natural components of the landscape.

A useful paradigm for treating the landscape in the formation of a conceptual regional site formation process-based model is to treat the maritime landscape as a “nonlinear dynamical system whose evolution is governed by abrupt transitions” (McGlade 1999). This does not preclude the presence and efficacy of non-abrupt transitions, but necessitates that they are not the primary mode of or condition rates of social and physical change. McGlade (1999) refers to this as a human ecodynamic approach, concerned with the dynamics of human-modified landscapes from a long-term perspective. This therefore is useful for the consideration of maritime landscapes and associated transport zones. The human–environment relationship involves the co-evolution of socio-historical and environmental processes and their intersection in time and space producing the socio-natural system as an analytical framework (McGlade 1999:462).

Sociocultural evolution is spurred by “positive” feedback, which produces temporary and/or permanent destabilizing social effects that push society through unstable transitions (McGlade 1999:464). The socio-natural system can be conceptualized as a framework of stored system energy. System efficiency is realized when energy enters the system as pulses (Odum 2007). Shipping accidents and accident mitigation, the invention of new shipping technology, and the discovery of a valuable natural resource can be considered systemic energetic pulses. Within an ecodynamic system, a small change in one variable can have catastrophic effects on the system as a whole. The social response therefore can be considered as a form of self-reorganization rather than mere adaptation to the effects of positive feedback (McGlade 1999:464). Often however, affective change is partial, with parts of society able to withstand change more than others.

Increased diversity of the temporal and spatial scales of phenomena within the landscape increases lag in social evolution, the results of which can cause disruptive sociocultural and natural dynamics (Gould 1983; McGlade 1999:465). Because in the short term, these system responses are nonlinear, it is necessary to define patterns in long-term behavior. In the long-term, discontinuous transitions that result in patterns of social activity and environmental events in nonequilibrium are normal (McGlade 1999:465).

Therefore, understanding patterns of behavior in the long term is the only really effective way to understand the behavioral components of maritime disasters and associated shipwreck distribution, and a landscape of maritime disasters is a very useful place to compile relevant data. Having a model within which to collate, interpret and communicate the data—and give due attention to oceanographic factors that influence the data—makes it comparable to similar research conducted in other areas, so that landscapes and individual archaeological sites can be connected to greater landscape processes.

The Evolution of Maritime Archaeological Site Formation Models

Formation processes of the archaeological record have been a concern of terrestrial archaeologists for much of the second half of the twentieth century, and constitute one of the tenets of the New Archaeology paradigm developed in the 1960s (Binford 1983). Hypotheses about formation processes were developed in the late 1960s–1970s through the application of the concept of entropy to archaeological sites; i.e., that potential site-derived information degrades over time. During the 1970s, the idea of transformation processes recognized that there is discontinuity between human activities, artifact deposition, and preservation and archaeological recovery or the creation of sampling bias. Previous work has shown that formation processes: transforms, sites, and regions formally, spatially, quantitatively, and relationally, can create distortion and artifact patterns unrelated to past human behaviors, but exhibit regularities that can be studied and expressed statistically (Schiffer 1987:9–11).

Work in model development for the understanding of shipwreck formation processes has lagged its terrestrial counterpart, but has continued to slowly evolve since Muckelroy first proposed his “evolution of a shipwreck” in 1978. All discourse on shipwreck formation processes understand that the environment and other natural factors contribute to the creation and, to some degree, modification of the archaeological record. Formation theory provides structure for applying information that is derived from the site (O’Shea 2002:10). Gould (1983:18) points out that many maritime and nautical archaeologists state that they implicitly include all the steps of “archaeological reasoning” in their research, including site formation, but that there is a need to be explicit in how the rules of science are applied to explanations of past human behavior. This “implicit” inclusion leads to inconsistent application of environmental factors in research and contributes to “the illusion of site uniqueness” (O’Shea 2002:3). Though recent research on specific shipwreck sites has at times been able to pinpoint specific natural events that have contributed to the wrecking of individual vessels or groups of vessels, scientists are just beginning to understand how the environment affects submerged cultural materials and vice versa (Lenihan et al. 1981; Forsythe et al. 2000; Jordan 2003). At both the local and regional levels, this is necessary “to develop a reasonable perspective in the rational utilization of the [archaeological] resource base” (Murphy 1983:80–81).

Even the latest models of site formation processes, those that include the oceanographic or limnological aspects of the formation process, fail to provide a thorough understanding of archaeological formation and preservation when one considers a maritime landscape. They oversimplify or ignore the movement of archaeological materials. This is not to say that this problem has yet to be addressed. Regional studies of shipwrecked materials, which take into account environmental factors, have been carried out both in the United States and abroad (Wheeler 2002; O’Shea 2002, 2004). These studies, however, do not explicitly

delineate a model that that can be applied generally to most or all maritime landscapes. They also only lightly touch upon the probability that environmental regimes may have quite specific preservation potentials which carries with it regional archaeological management significance (Wheeler 2002:1151).

To fully understand the proposed landscape formation model, it is necessary to derive its evolution through previous modeling attempts. Muckelroy was the first to explicitly put forth that shipwreck phenomena contain common features (Fig. 2.1). This implies that when evidence can be ascertained and tested on sites where historical evidence is present, it can also be applied where historical evidence is lacking. Therefore, archaeological evidence is inherently homogenous with at least some degree of cohesion and the assemblage can be approached as a system defined by the characteristics of a ship which may have gone through a series of transformations through time (1978:157–159). Muckelroy's shipwreck evolution model interprets the site formation process as a closed system with only the ship as an input. There are extractive (salvage, disintegration, dissolution, etc.) and scrambling devices, which include the wrecking process itself and seabed movement.

Based on review of studies that attempt to measure the quality of archaeological remains through parallel biological and geomorphological marine studies,

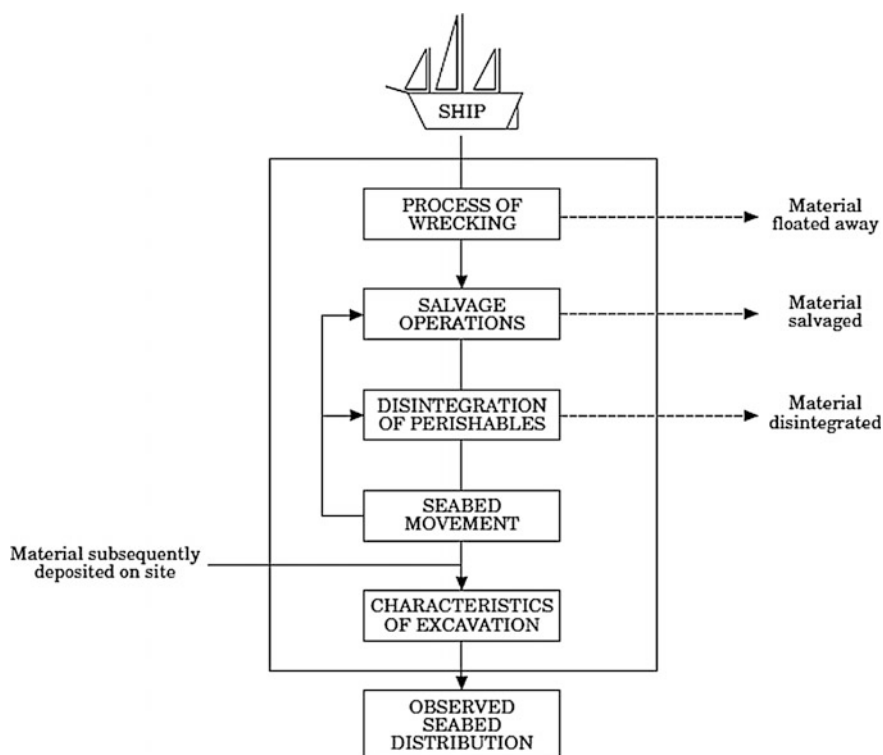


Fig. 2.1 The first shipwreck site formation model (Muckelroy 1978)

Muckelroy (1978) characterizes what he considers to be relative environmental attributes that contribute to material extraction and scrambling. He determined that the geomorphology or nature of the seabed deposit is the most important control for determining site scrambling and cohesion (survival) of archaeological remains underwater. The most deterministic forcing factors are: maximum offshore fetch, sea horizon or open water, average slope of the seabed, recent underwater topography, and coarse versus fine sediment as deposit matrix. Less relevant attributes are tidal stream speed and depth of site.

Muckelroy's attempt to classify well-known shipwreck sites according to cohesion, presence, and amount of extant archaeological material with observed environmental impacts is descriptive and not causal. He states that it is not possible to predict the likelihood that remains will be found in a location known to have been a wrecking site, and that the model neither addresses variability between sites of similar geomorphology, nor does it look at the wrecking process as a single event (1978:165).

This formation model is rather simplistic, as it does not consider inputs that are themselves defined in the present as archaeological such as floral and faunal attraction to the site (as habitat) or post-"shipwreck" anthropogenic input such as salvage process debris, memento deposition, net snags, etc. It also does not allow for extraction due to non-"floating away at time of wrecking" means. There are other extracting filters besides salvage and disintegration once the site has reached "stabilization" such as storm surges, currents, waves, ice movement, etc., especially in lacustrine environments.

While in general there is little cause to dispute Muckelroy's deterministic factors affecting material extraction and site scrambling, it is erroneous to believe that they can neither predict the probability that archaeological remains will be found in a given location nor that they can address site variability. The probability that remains might be found in a given location is inherent in Muckelroy's process of wrecking if the deterministic factors are taken into account. Both site location and intersite variability can be addressed if the model is expanded to include the material once it has been extracted from the primary archaeological site, or in other words, if archaeological material is recognized to remain a tangible part of the landscape. In addition, O'Shea (2002:8) notes that the use of "scrambling device" as a term for material movement implies a randomization or pattern diminishing effect (entropy), which is inaccurate.

Nearly a decade after Muckelroy proposed his site formation model, Schiffer (1987) more precisely defined how to characterize site transformation processes by dividing them into two categories, cultural and natural, termed in turn c-transforms and n-transforms, and breaking down process effect components to three levels: the artifact, the site, and the region. While Schiffer was considering terrestrial archaeological deposits and does not appear to intend the work to be considered a model per se, it can be used to define both physical and spatial inputs into an underwater formation process model. Most importantly, it is understood that sites are open systems and, therefore, one should include inputs other than the initial deposit and materials once they have left the immediate site area (1987:151).

C-transforms are defined as the processes of human behavior that affect or transform artifacts after their initial period of use in a given activity and are responsible for retaining items in a systematic context to form the historic and archaeological records as well as for any post-depositional modification. N-transforms are any natural processes that effect archaeological deposits by deterioration, decay, alteration, or other modification and can add environmental material to the site. Unlike c-transforms, they are to some degree continuous. Resulting transformation/modification for both types of transforms are both regular causally and consequently making the processes and their effects predictable and thus able to be statistically modeled (Schiffer 1987:7, 21–22, 143).

Schiffer (1987:199) also shows how when approaching the archaeological record, c- and n-transforms can be invariably linked. Non-cultural processes will affect behavior that potentially causes c-transforms to occur. For example, environmental factors might keep sailors from venturing into certain places due to historically understood geological, physical, or other concerns (shoals, cross-currents, whales, etc.).

N-transforms must also be taken into account when approaching an archaeological landscape. They can affect both site visibility and accessibility. They can also bias survey and sampling regimes, for example, sedimentary processes may variably expose or cover some or all of an archaeological site rendering its identification in a side-scan sonar survey dependent on the sedimentary conditions on the day that the survey takes place. Identifying formation processes in the archaeological record implies that they occurred. It is necessary; therefore, to be explicit as to their effects and without extensive analysis it may be impossible to separate the archaeological remains from them. This is especially true when one considers that there can be much variability in the effect of transforms (Schiffer 1987:265–267, 302).

In any case, it is important to identify formation processes before behavioral and environmental inferences are made so they can be filtered from the anthropological phenomena of interest (Schiffer 1987:303). Gould (1990:21, 53–54) terms these as first-order and second-order variables. First-order variables are the constraints of the environment (n-transforms) as well as anthropological limitations, such as the state of technology at a given time. Second-order variables are the “human factor” or specific behaviors (c-transforms) that will aid in a better understanding within a cultural-historical context (i.e., desired anthropological information). In other words, formation process controls must be ordered. The need for second-order variables defines Gould’s “Operational Theory”, which assumes cultural uniformitarianism and a form of middle-range theory (contemporary and historical) to derive c-transforms that can be applied to and/or filtered from the archaeological remains (1990:49, 55). Examples of operational theory are the “One More Voyage Hypothesis” (Murphy 1983) and “Technological Trend Innovation”. The latter is the perpetual improvement, including increased complexity and cost, of a traditional industrial system that over time is rendered increasingly obsolete. At least one segment of the social hierarchy has a stake in the perpetual production of the system (Gould 1990:170–189).

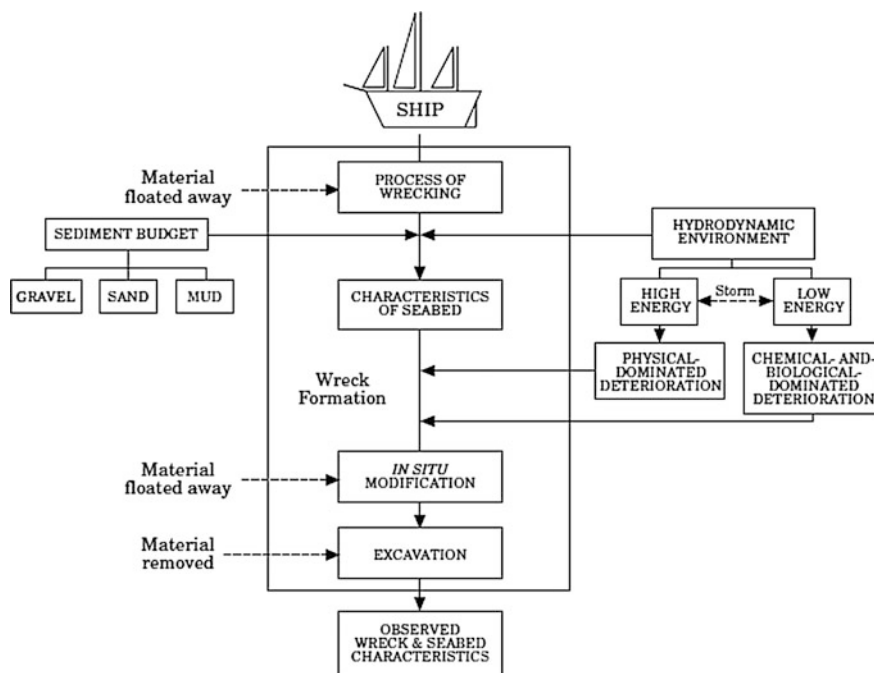


Fig. 2.2 Dynamic processual shipwreck site formation model (Ward et al. 1999)

Ward et al.'s (1999:561–563) processual site formation model was the first to incorporate dynamic natural transforms into the core of the model (Fig. 2.2). It is predictive, process-oriented, and scale-independent. Shipwreck degradation is characterized by the sum of direct and indirect affective environmental processes plotted against the local sediment budget (considered a first-order control) over depositional history. The environmental processes are physical or hydrodynamic, biological, and chemical. It is clear that most, if not all, of these processes are interrelated and cannot be considered apart from one another. This model is excellent for characterizing site formation processes within the context of an individual archaeological site.

The sediment budget is defined as the rate of net supply or removal of different types and sizes of sediment grains to the site area. Ward et al. (1999:564–565) recognize the link between sediment budget and hydrodynamic forcing; however, consider it separately because one does not assume the other bidirectionally. The sediment budget influences the extent of development of reduction-oxidation zones within the sediment. For many sites, it may be possible to examine sediment profiles to determine the history of the sediment budget.

The nature of the hydrodynamic environment is variable in time. Physical effects have greater impact in high-energy environments and biological and chemical effects have greater impact in low-energy environments. The site can transition to

and from high-energy environments to low-energy environments, and at any stage, material can be lost. There are an infinite number of different process paths a site could progress through to reach the “present” state (Ward et al. 1999:565, 568).

Ward et al. (1999) approach the visual interpretation of the model as a revision of Muckelroy’s (1978) flowchart. This flow chart adds the sediment budget and the hydrodynamic environment as inputs into the process of pre-stability site formation; therefore, the wrecking process is no longer a single unidirectional path toward site stability. Obviously, different site types degrade or are affected in dissimilar ways, but it is clear that these factors have a greater influence on the modification of the site than if one only considers the ambient “steady-state” environment (Ward et al. 1999:564). This equilibrium environmental characterization can be used to normalize the forcing factors when comparing sites and/or loci.

The most recent dynamic site formation model assumes Ward et al.’s (1999) natural transformational process, expanding it to include the range of cultural processes, before, during, and after a shipwreck and the long-term relationships between people and shipwreck sites (Gibbs 2006:4–5) (Fig. 2.3). Gibbs (2006:7) argues that cultural transforms should be structured, not as pre-depositional, depositional, and post-depositional, but around the nature of the event and the sequence and range of potential responses at each stage of the event.

Using Leach’s five major stages of a physical disaster, a shipping disaster follows the following processes (Gibbs 2006:7–13):

1. Pre-impact: the pre-impact stage comprises a period of recognized potential threat and a period of warning in which evidence indicates that an accident is likely to occur. A threat may be real, manufactured, or imagined (Duncan 2004:15) and it may or may not be understood. During the warning period, mitigation can be physical and/or spiritual and successful mitigation can result in an arrest in accident progression.
2. Impact: the impact stage is the moment of a disaster event through the realization that the event has occurred and mitigation must take place. Disaster studies have shown consistent trends within groups during the impact stage with only a small proportion of the group able to respond immediately and effectively. The remainder is often bewildered or behaves inappropriately. Mitigation may include jettisoning cargo or fixtures, patching a leak, or intentionally grounding a vessel.
3. Recoil: the recoil stage commences when the immediate threat to life has receded or that the primary disaster event has been survived. This does not mean that involved individuals are out of danger. It is possible that a vessel can be successfully mitigated out of both the impact and recoil stages resulting in no shipwreck archaeological site. Other event-related materials might be retained to form the archaeological record (e.g., flotsam, jetsam, etc.).
4. Rescue: the rescue stage commences when the person or group involved in the disaster has been removed from danger. Often, this is where many of the first documentary accounts of the event are generated such as in life-saving station logs or rescue vessel logs.

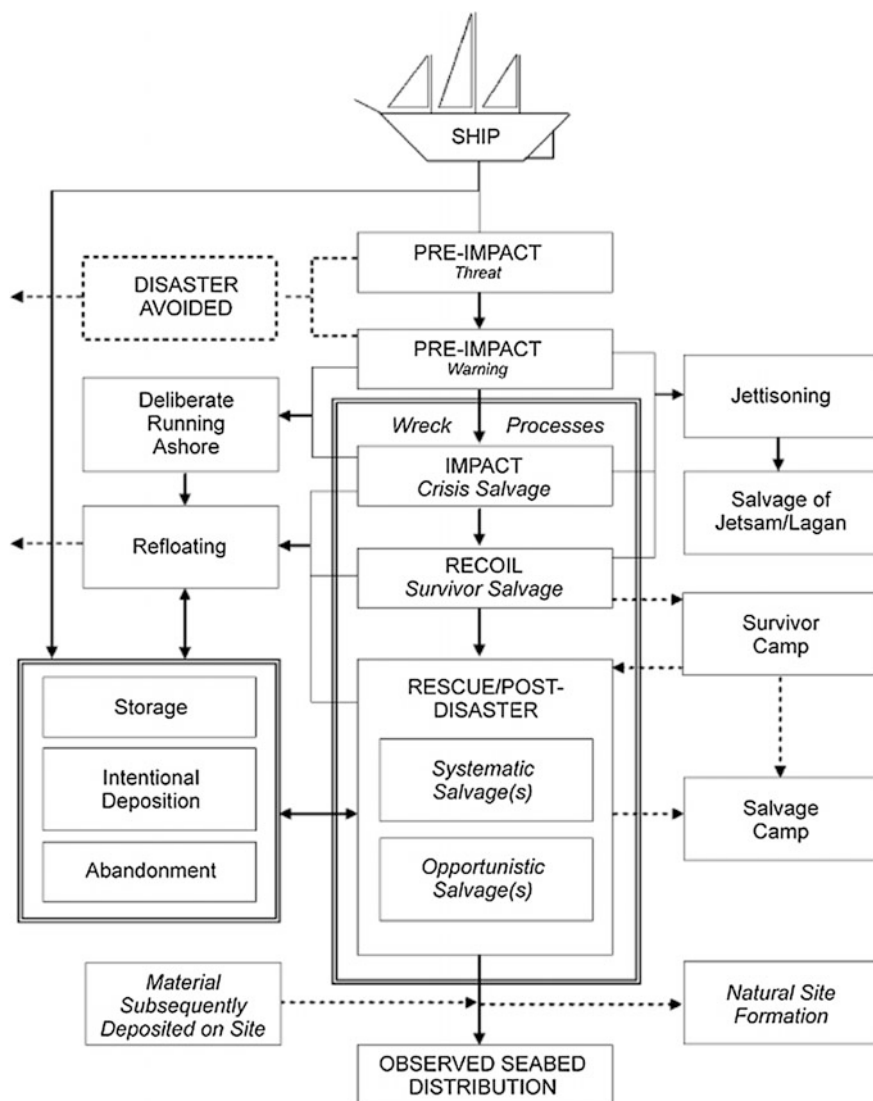


Fig. 2.3 Dynamic cultural processes in shipwreck site formation model (Gibbs 2006)

5. Post-trauma: post-trauma is the medium- and long-term response to the event. Most primary documentary accounts of an event are produced at this time. This can include insurance reports, newspaper articles, etc.

Gibbs (2006:14–15) also recognizes the importance of salvage as a key formation process of archaeological sites and rightly recognizes the variability in the methods and effects of salvage in different disaster stages. Salvage can begin during

the recoil stage and continue long after the disaster participants are no longer actors in the life of the shipwreck. Salvage is variable over time and is dependent on site accessibility, the time and effort required to salvage, the perceived benefits versus cost, and the legality of the endeavor. Opportunistic and organized salvage can occur in several cycles and in either order. This also applies to mobilized wreckage such as cargo, other materials, and even corpses that wash ashore.

Gibbs arranges the pathways of his processual model by modifying Muckelroy's flowchart to include explicitly defined c-transforms present in terms of the five stages of the shipwreck event. In other words, it follows the process of the associated human activity. Ward et al.'s (1999) natural transformation model is the continuation of the dynamic formation processes that affect the site apart from human interference and therefore does not overlap with the cultural transforms.

Though it acknowledges archaeological materials distributed off-site through human activity, the model is designed to specifically address the formation of a single archaeological site; it only implicitly assumes the presence of removed material elsewhere. This in itself is not a failing of the model, but rather the model assumes that what is of interest is the formation of the immediate site location of the shipwrecking event and that associated materials would be included when investigating the particulars of associated activities. Gibb's (2006) model does, however, only include purposeful cultural transforms; it does not include inadvertent or incidental human activity that affects shipwreck sites such as channel dredging or snagging towed gear.

While the Ward et al. (1999) and Gibbs (2006) models appear to be excellent for a rigid site definition, they do not allow at all for site parameter flexibility. The site must derive from a single event and is therefore strictly locational. It is not useful for characterizing an archaeological landscape and all the archaeological materials contained within. Additionally, the preceding models in general do not allow for the inclusion of many types of archaeological materials located with the maritime archaeological landscape. This includes wreckage that has broken away from shipwreck sites, either in the process of wrecking, or after the archaeological site has initially formed. Archaeological material can derive also from other, non-ship types of maritime transportation and infrastructure such as log rafts, fishing, and other non-transportation activities. All of this cultural material is an integral part of the maritime archaeological landscape.

A Maritime Archaeological Landscape Formation Model

To create a useful maritime archaeological landscape formation model, archaeological space and time must be analyzed in three dimensions, including the surface and water column in addition to the sea floor (Fig. 2.4). There are three levels or stages of analysis within this system upon which variables can act. In terms of a vessel these are: (1) that a vessel will wreck or become irrecoverable in a given location at the surface; (2) that wreckage will arrive at a given location; and (3) and

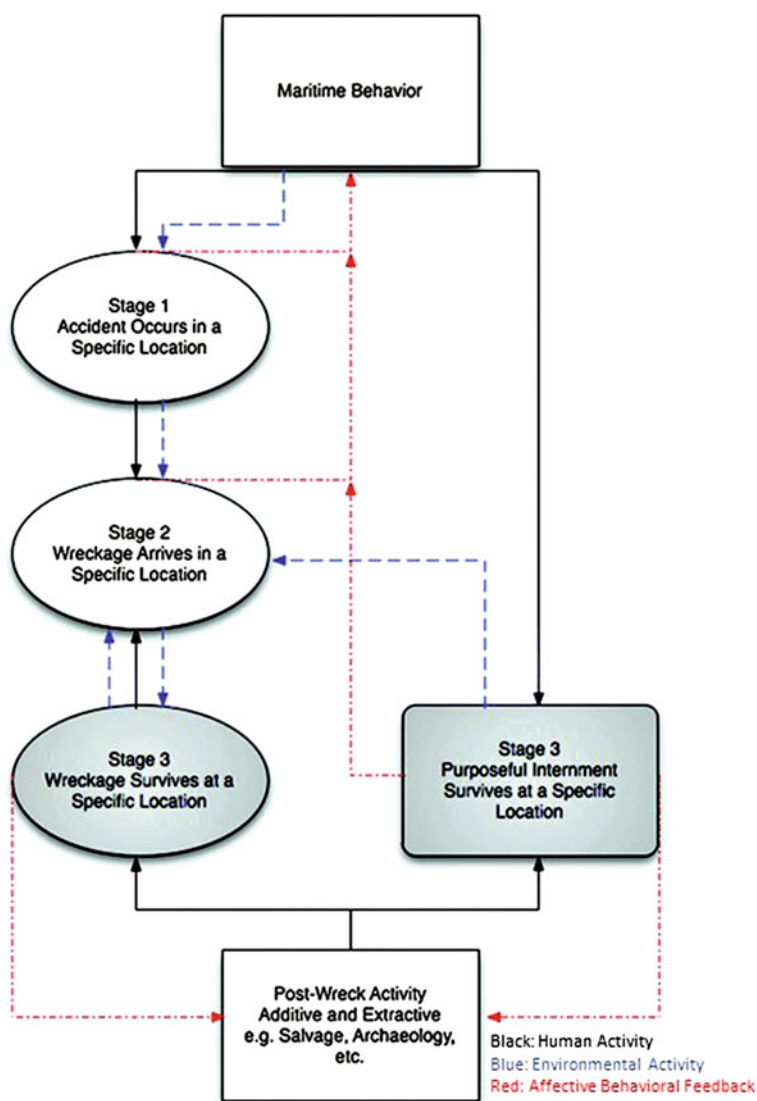


Fig. 2.4 Dynamic processual maritime archaeological landscape formation model

that wreckage will survive at a given location. Each shipwreck or wreckage must go through each of these stages of transformation. Additionally, once reaching the third stage, mobile wreckage may become re-entrained within the system, due to c- and/or n-transforms, and continuously cycle through stages 2 and 3. While in stage 3, the Ward et al. (1999) model is applicable for all submerged archaeological remains.

The model is generalized in order to be applied to any definable maritime landscape. Formation transforms are defined as environmental inputs that can be characterized or measured in space. They can be both variable and non-variable and exist at different scales. These transforms can be measured directly in the environment, derived from historic data, or inferred from historic accounts. Depending on the area and scale studied, different transforms will have more influence than others.

In order to approach the maritime landscape as a human ecodynamic system, it is impossible to separate anthropogenic and natural phenomena (McGlade 1995:359) as with the models of Ward et al. (1999) and Gibbs (2006). The former treats c-transforms as an arbitrary initial input and the latter does not incorporate n-transforms into the sociocultural model except to assume the forcing of behavioral constraints over time. Additionally, neither allows for positive feedback from landscape events over time to affect the continual cycling of landscape formation processes. The landscape is not merely a sum of the events that take place within it.

To combine anthropogenic and environmental processes into a single landscape formation model, it is necessary to treat the landscape as an irreducible socio-natural system (McGlade 1995:359). Additionally, though previous formation cycles inform human behavior, individual shipwreck and other internment events are essentially mutually exclusive. It is a nonlinear system where behavior cannot be reduced to a mathematical algorithm. What is needed is a model that acts as an abstract dialogic resource that can carry multiple analytical arguments through a variety of model scenarios and various temporal and spatial scales (McGlade 1995:361). This approach allows for the combination of different types of data including descriptive, deductive, and interpretive datasets.

McGlade (1995:361–366, 384) has developed an organizational structure in which this approach is possible. A framework is required in which empirical data are situated within an interpretive as opposed to a deductive frame of reference in order to facilitate an interrogative dialogue between qualitative and quantitative data. Instead of a model as a representation of real-world phenomena, the model becomes a dialogic resource constructed around the potential interaction between model sets within which multiple possible arguments can be formed. Each problem set or inquiry requires appropriate submodels to address different aspects of observed phenomena within different boundary domains. Instead of a single predictive model, inquiry leads to a series of potential evolutionary pathways to which a system is prone. The model allows for selective component access to address specific problems related to the dynamics of the system. The modeling process provides an “experimental arena” within which different interpretations are possible hypotheses that can be tested.

Unlike all previous models all human behavior associated with maritime activities is incorporated with the landscape formation model, because they fundamentally take place within it. This includes behaviors that are not directly included in the wrecking process such as successful maritime voyages and modern salvage activities.

Each stage in the model can be construed as a “black box”, which represents an infinite number of potential c- and n-transforms that are bounded by the unique conditions present at a given time and that evolve over time. Except for “Maritime Behavior”, which can be construed as being continuous throughout all or limited to a part of the landscape, every stage within the model is associated with a particular location on the landscape. As people and materials move between stages, this location may stay the same or change.

Once materials arrive at Stage 3, on the sea floor, an archaeological site is formed. There are two pathways through which this can occur, through an accidental internment (Stage 3a) or through a purposeful internment (e.g., pound net stakes, wharf pilings, etc.; Stage 3b). On the landscape, these sites are contingent on the moment of observation. While some archaeological sites persist through their initial formation to the present, others may have a finite lifespan controlled through time-dependent c- and n-transforms.

Both cultural and natural forces drive the system through the three stages. These forces are time dependent. For physical changes on the landscape, these can be either unidirectional or bidirectional. The bidirectional forces create cycles within the system. The dominant cyclical physical process is the entrainment of archaeological materials from an established site into the water column, essentially returning it to Stage 2, where it will then be deposited elsewhere creating a new site. Environmental forces involved might include storm-induced currents and waves or ice scouring, and human forces might include purposeful activities such as dredging and dumping of spoil.

An accumulation of input into any stage may split and continue the formation model at different locations ultimately forming unique archaeological sites within the landscape. For example, cargo may be jettisoned during accident recoil; a portion of the crew may leave the vessel in a lifeboat; wreckage may differentially disperse on the surface; or a portion of material may become entrained into the water column and be carried from an archaeological site.

What makes this model truly a landscape formation model, as opposed to an archaeological site population model with mutually exclusive site formations taking place intrasite, is the creation of positive feedback that drives the continuous flux of human behavior, which in turn drives the entire system as it affects the primary input: maritime behavior. This feedback can initiate from several stages, may not be the same at different stages, and may affect the overall system differentially. Both the feedback itself and the effects of the feedback are contemporarily unpredictable. It may be ignored, misunderstood, perverted, or dismissed, and disparate groups or individuals might use and respond to it differently.

Additionally, because maritime behavior and environmental forces occur as parts of the landscape as a whole, areas within the landscape that do not contain

archaeological materials retain their importance within the system and cannot be discounted or ignored. Just as dynamic behavioral and physical processes are deterministic factors in the creation and presence of archaeological sites, they equally inform the lack of sites and any given place.

The continuous cycling of the dynamic formation of the landscape creates a system that can absorb the effect of force inputs. Systemic steady state is not synchronous between the landscape and processes occurring intrasite. Perturbations within the system at any stage may affect or may not affect a particular location or site but always affect the landscape. Because the formation of the landscape is tied to both time and place, different parts of the model can be accessed to address specific questions posed to it. Understanding every possible input into the model is not required for it to function as a dialogic resource for inquiry.

Formation of the Maritime Archaeological Landscape of Thunder Bay, Lake Huron: Decade of Loss

Thunder Bay is located in northwestern Lake Huron near the city of Alpena, Michigan. The 4300 square miles of sanctuary hold at least 100 known and identified shipwrecks and perhaps another 100 unidentified shipwrecks, at various depths ranging from 0 to over 100 ft. Most of the known shipwreck sites and many of the unknown shipwreck sites, derive from familiar, well-known ships and events. Dating primarily between 1860 and 1930, historic records reveal their names, the identity of their crew, the form and construction of the vessels, their cargo, and when, where, why, and how they wrecked.

The ~70 years of shipping disaster represented by these shipwrecks indicate that safety at sea was a real pervasive concern for those tied to the lake for their livelihoods. The differences in the circumstances of these shipwrecks allow us to tease out behaviors tied to the landscape. For example, Thunder Bay was considered the only safe harbor during storms along Lake Huron's northwestern coast. Many of the ships that wrecked at Thunder Bay foundered or stranded while seeking shelter along the southern shore of North Point peninsula. Additionally, pilot books from the late nineteenth and early twentieth centuries promoted the lee passage between Thunder Bay Island and North Point as safe harbor for ships in peril. This passage, however, is characterized by dangerous reefs, which require careful knowledgeable piloting, a difficult chore in calm weather let alone in heavy seas. Pecoraro (2007) has shown that this lee passage actively functioned as a ship trap that served to concentrate maritime accidents into a condensed area.

Through the use of this maritime archaeological landscape formation model, patterns and trends in commercial shipping and associated human behavior become readily apparent in the submerged archaeological record. As a whole, the spatial patterning of shipwrecks in the region is not random. Nearest neighbor analysis of all historic shipwrecks (Fig. 2.5), even when the position of any shipwreck only

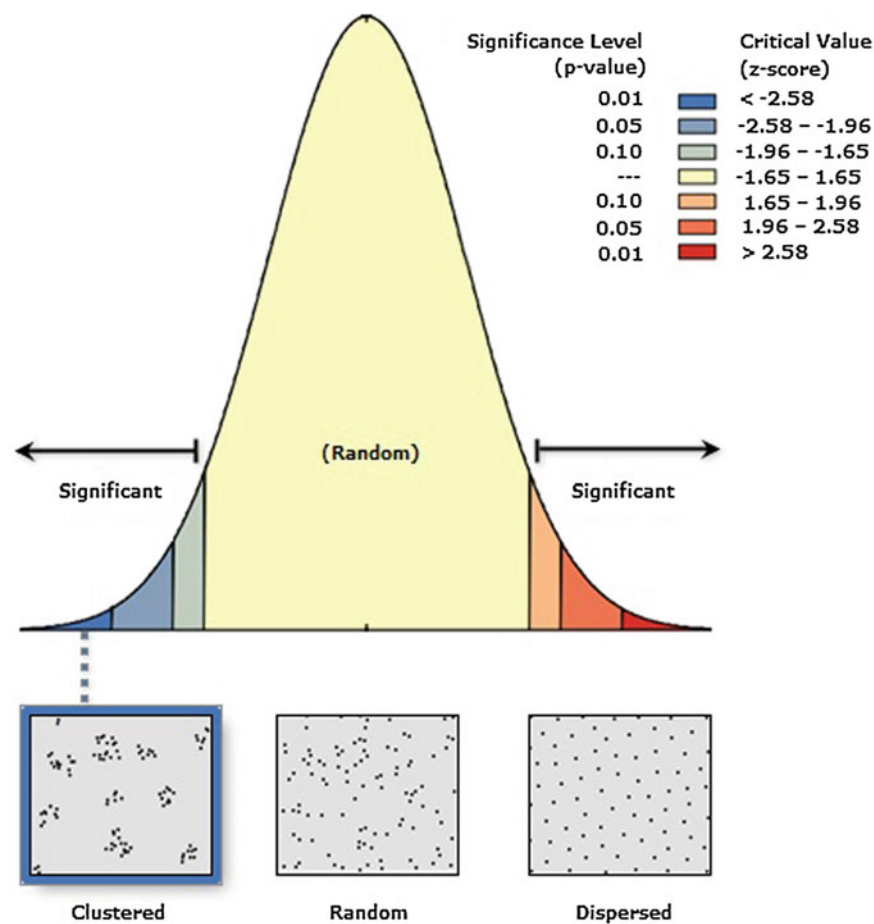


Fig. 2.5 Nearest neighbor analysis of shipwrecks in the vicinity of Thunder Bay

known through the historic record is estimated, indicates that there is a less than 1% likelihood that the pattern is the result of random chance, further supporting the model theory that formation processes do not begin with an archaeological site’s initial deposition on the lake floor. In the context of the model, it becomes easy to explore how the social conditions of the period between 1830 and 1930 informed the maritime behavior that best explains the historical and spatial distribution of archaeological materials associated with primary shipwreck sites. This discussion considers patterns associated with decade of loss (Figs. 2.6 and 2.7).

The total number of known shipwrecks in the vicinity of Thunder Bay in the 1830s through the 1850s is relatively low due to the small number of vessels on the upper Great Lakes at the time, little commercial activity around Lake Superior, and possibly because of limited recording of shipwreck accidents, though as they would

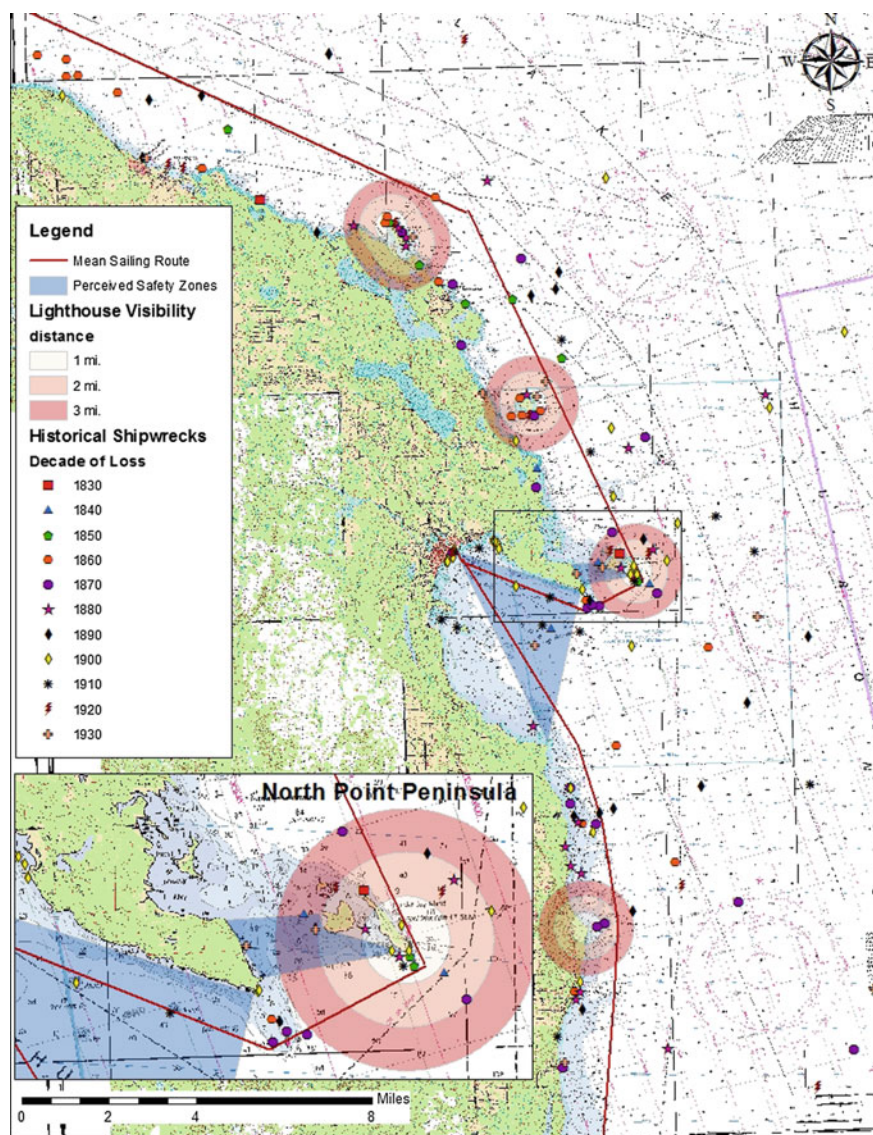


Fig. 2.6 Decade of loss (spatial)

have been rare and costly, any severe accident would likely have been noted. Because steam-powered vessels were expensive, fewer risks would have been taken with their use; therefore, it is unsurprising that only four wrecked during these decades.

A lack of spatial patterning of shipwrecks during these decades indicates unfamiliarity with the coastline, as the coast had yet to be surveyed and pilot books

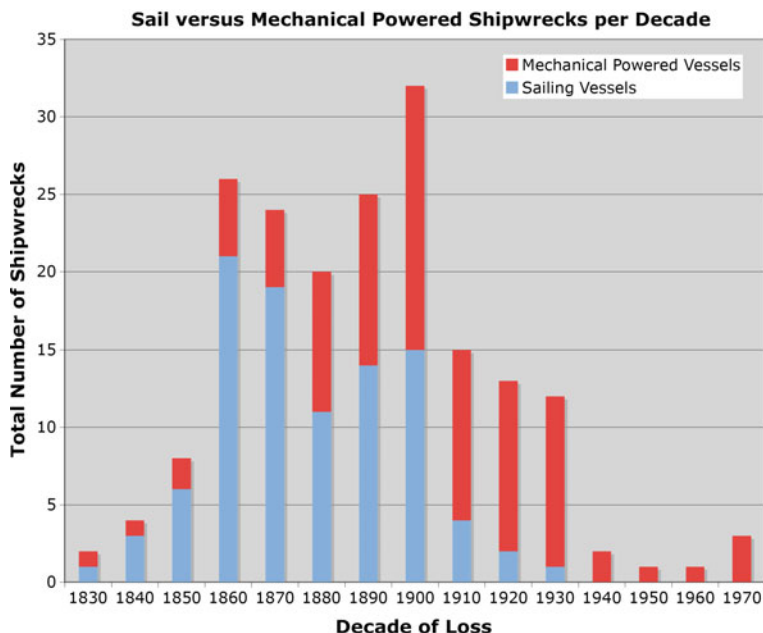


Fig. 2.7 Decade of loss (graphical)

were unavailable. All shipwrecks before 1860, however, took place within or immediately adjacent to the coastal transport zone either in shoals or within the historic shipping lane. It appears at this time that the corridor between Thunder Bay and Sugar Islands and North Point and the lee side of Presque Isle were becoming recognized as a perceived safety zones for imperiled vessels as several wrecks occurred in these locations. This informal designation was probably the primary motivation for the construction of the regions two earliest lighthouses, one at each of these locations.

The period of 1860 through 1900 saw a significant increase in the total number of shipwrecks in the vicinity of Thunder Bay with sailing vessels making up at least half of the wrecks for every decade except 1900. This indicates that as the ratio of new steam-powered to sailing vessels increased, sailing vessels became increasingly marginalized as a profitable method of shipping and variable risks would have been taken by sailing and steam-powered vessels owners. It also explains the split in the rates of growth, with sailing vessels being much higher, of the average ages of shipwrecks of these two propulsion systems throughout this period. The percentage of sailing vessels that shipwrecked compared with the total fleet also increased throughout this period, while the percentage of steam-powered vessels that wrecked remained stable. The latter is not unexpected, as overall, fleet size grew with tonnage availability even as cargo capacity became increasingly larger.

An interesting spatial patterning of shipwrecks occurred between 1860 and 1900. The 1860s saw significant clustering of shipwrecks at three primary locations: at Forty-Mile Point, Presque Isle, and Middle Island. All of these locations were nodes of sailing direction change. Forty-Mile Point was a new navigational node, beginning in 1860s with the development of copper mining, for vessels sailing to and from Lake Superior. This is also the area where vessels sailing from Lake Michigan and Lake Superior merge to form a single southbound corridor. Nearly every shipwreck at this node sank due to collision indicating unfamiliarity with the route and a lack of recognized formal sailing directions.

The perceived danger zone at Presque Isle was mitigated by the construction of a new lighthouse. The 1870s saw no apparent overall clustering. This changed in the 1880s with apparent clustering at Thunder Bay Island and Presque Isle and also north and south of the new lighthouse at Sturgeon Point. As few wrecks had occurred previously at Sturgeon Point, this indicates that the lighthouse became a perceived safety zone on the maritime landscape at this time. Also, new pilot books in the 1860s and 1870s had formalized the North Point corridor as a perceived safety zone on the landscape. Again, there was little clustering in the 1890s, then, again, clustering in the 1900s around Thunder Bay Island.

This cycle of clustering over a 50-year period likely represents a behavioral reaction on a decadal scale of the maritime community to perceived dangers on the landscape. When apparent clusters of shipwrecks occur in a recognized period of time, both the perceived and real risks are mitigated, through coastal survey, the distribution of pilot books, and the erection of lighthouses, and in the latter half of this period the institution of life-saving stations. While accidents do occur at these locations afterward, the pattern of shipwreck location becomes much more diffuse. Over time, the institutionalization of their presence and their associated risk mitigation, coupled with changes in maritime technology and general maritime transport and commercial shipping conditions, forces the cycle to begin anew with new patterns of clustering that fit the new maritime landscape conditions.

The number of shipwrecks in total fell precipitously between 1910 and 1930. Few wrecks of sailing vessels illustrate their essentially complete marginalization in commercial shipping. All new commercial vessels built during this time were iron, the majority steel freighters, yet most of the shipwrecks of steam-powered or other mechanized vessels at this time were old wooden-hulled boats. Only a small percentage carried bulk commodities and those that did carried relatively non-valuable cargos compared with iron ore, therefore it is likely that these vessels were for the most part competing in regional trading activities. A preponderance of tugs indicates that many accidents occurred in a local context. Throughout this period, the spatial distribution of shipwrecks continued to contract in general toward Thunder Bay.

Hot-spot analysis of shipwrecks of sailing vessels in the region reveals some interesting patterns (Fig. 2.8). Hot-spot analysis measures the standard deviation in spatial clustering of an attribute relative to other individual points, point clusters, and attribute clusters. A hot-spot will have points of closely clustered attributes spatially restricted from other points or clusters. A cold spot will have clusters of points but with mixed attributes. Lastly, a neutral spot will have either clusters of an

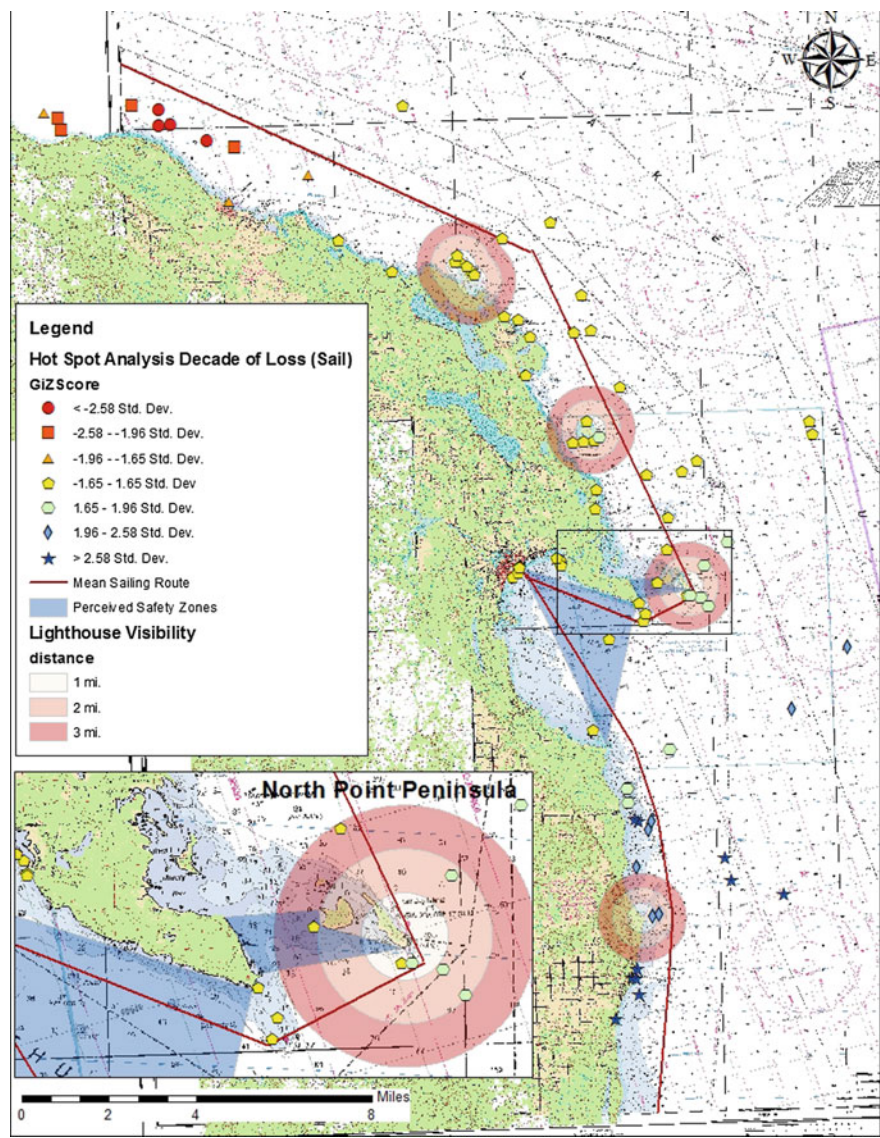


Fig. 2.8 Hot spot spatial analysis of decade of loss (sail)

attribute in close proximity to clusters of another attribute or a diffuse collection of points. In the vicinity of Thunder Bay, shipwrecks northwest of Presque Isle form hot spots from the 1860s and the 1890s. Moving southward along the coast, there are neither hot nor cold spots between Presque Isle and North Point indicated that clusters of shipwrecks in any given decade do occur; however, they are in close proximity to other clusters of shipwrecks and shipwrecks that are diffuse on the

landscape. This is not unexpected in an area with a large overall number of shipwrecks compared with the rest of the region. There are cool spots located around Thunder Bay Island and North Point indicating clusters of wrecks from several decades. South of South Point, shipwrecks from several decades are highly clustered in proximity to one another. There are no hot or cold spots with regards to steam-powered vessels.

Conclusion

In general in Western society, oceans and lakes have been considered as in the realm of the chaotic, each event mutually exclusive. The outcome of the voyage was thought of as inherently random. Human behavior on the maritime landscape and the environmental variables, which inform and constrain it, however, are not chaotic and random. Approaching maritime archaeology from a landscape perspective reveals patterns of human behavior that can be empirically studied to reveal the constantly evolving process of negotiation within society and with the natural world.

While methodological approaches to the study of the physical landscape are generally quantitative, it is impossible to combine attributes of the social cognitive landscape with it that can fit into these analytical paradigms. Human behavior that works to produce the archaeological record in any given instance is not fully predictable; however, the result of these actions is measurable in both the historical and archaeological record. The lack of predictability explains why existing models that provide a systemic framework for the analysis of archaeological formation processes begin with the identified results of behavior, the creation of a shipwreck or other submerged archaeological site. The most robust of these models, Ward et al. (1999), is excellent for the analysis of dynamic formation processes on unique archaeological sites that are inherently linked with specific locations on the landscape. This is adequate for the analysis of intrasite archaeological formation processes and their associated physical expression.

These, models, however, discount socially constrained human behavior that works to create the opportunity for the archaeological sites to form. They also decouple the result of the action/accident from affecting both future maritime activity and the evolving understanding of the past. Additionally, these models are fundamentally tied to place. When mobilized wreckage is entrained within the physical system and moved elsewhere or is salvaged from the archaeological site, it is eliminated from consideration in the models.

The maritime archaeological landscape retains all archaeological materials within and associated with it as well as the human behavior and, perhaps more importantly, the contemporary and historical understanding of its results and the associated social responses to it. These are, of course, variable, as they are dependent on interest, environmental and technical knowledge, and economic and social power. They also evolve variably over time. Tangible evidence for it may be found in the archaeological record or derived from the historical record; however,

this information must be interpreted leading to essentially qualitative analyses of the maritime landscape.

The maritime archaeological landscape formation model allows for the incorporation of both quantitative and qualitative analyses, conducted at variable temporal and spatial scales, into a single cogent interpretive framework. The model functions as a dialogic resource or arena in which subsections of the framework can be accessed in order to address specific scientific questions or to formulate hypotheses that can be addressed through nested modes of inquiry. The model allows for an infinite number of nested models of any type within all of the enclosed realms of activity present in the maritime landscape. The power of this model to produce new hypotheses in which to pose to the archaeological record is well-illustrated in the above example of nineteenth and early twentieth century sailing in and around Thunder Bay in northern Lake Huron.

The proposed hypothesis is that participants in this maritime landscape recognized patterns in accidents related to commercial shipping on a decadal scale. Feedback packaged at a decadal periodicity was powerful enough to affect maritime behavior. By looking at the patterns of commercial shipwrecking activity within the maritime landscape by decade, it has been possible to reveal evolving patterns of maritime behavior over time. It is clear that individual accidents that could potentially result in shipwrecks were expected, and maritime behavior changed little specifically in response to them. What was required to fundamentally change maritime behavior was extra-normative discoveries, inventions, internal and external pressures, events, and accidents, the latter often involving shipwrecking.

In the classical anthropological sense, Muckelroy is correct in his overarching statement:

The study of the wrecking process itself is of limited intrinsic significance, its importance lying rather in the link it provides between the remains investigated and the original vessel. Furthermore, the potential and limitations of our understanding of the latter by archaeological means ultimately defines the scope of the whole subdiscipline of maritime archaeology (1978:215).

This is not a comprehensive view for why we need to study archaeological site formation processes. With the recognized importance of being stewards managing the archaeological landscape, understanding the nature of the archaeological landscape and its associated maritime behavior is as important as determining the anthropological and historical information that can be derived from it.

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