THE IMPORTANCE OF STURGEON ALONG THE MIDDLE HUDSON RIVER DURING PREHISTORIC TIMES: A FAUNAL ANALYSIS OF THE TUFANO SITE

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by

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ABSTRACT

This laboratory project focused on food remains at the Tufano archaeological site in Greene County, New York, as a model for late Middle Woodland subsistence in the middle Hudson Valley, ca. 1300 years ago. The goal was to contrast numbers of terrestrial species with aquatic and semi-aquatic species, with particular attention given to the archaeological evidence of sturgeon, *Acipenser* sp. The comparative collection at the New York State Museum enabled identification of the faunal remains. White-tailed deer and sturgeon were the only species in the top rankings of the three calculation methods used. Although aquatic species did not provide the bulk of meat in pounds for the inhabitants at the site, riverine resources provided an important dietary constituent. The archaeological evidence points to an increased importance placed on sturgeon and other aquatic resources in the middle Hudson Valley, starting in Middle Woodland and continuing into Late Woodland times. The specific purpose of Petalas blades, a special form of knife found at Tufano and other archaeological sites, could not be determined by association with faunal remains. Their appearance, though, seems to coincide with the peak in sturgeon utilization seen in Middle Woodland times. Numerous storage pits and post molds at Tufano are evidence of increased sedentism, which may have been a contributing factor to the later transition to agriculture in the region, at the beginning of the Late Woodland period, ca. 1000 years ago.

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INTRODUCTION

This research seeks to study the relationship between people and Hudson River resources in prehistoric times from the Highlands to the northern end of the estuary in Troy, New York. The goal is to determine the extent to which people relied on Hudson River resources for their subsistence during the few centuries before farming began. This increased dependence may have contributed to the development of sedentism among Middle Woodland people that began around 1,600 years ago, and to the eventual transition to agriculture in the region that took place about 1,000 years ago. Because of its preservation and abundance, a particular focus was placed on the remains of *Acipenser* sp. in the New York State Museum collection from the Tufano site in Greene County, New York. Determination of dietary importance was based on the contrast between aquatic and terrestrial faunal remains. Included in this research is general, historic, and current information regarding Hudson River sturgeon. Fishing implements and artifacts believed to be associated with sturgeon processing will also be covered.

The Tufano site lies on a low terrace just north of Fourmile Point, a rocky peninsula that extends into the Hudson River, in the township of Coxsackie. William A. Ritchie and Robert E. Funk excavated less than one-tenth acre of the site in 1963 and 1964. An area approximately twice the size of the excavation area was destroyed by a borrow pit for a sand dock and a road, and could have yielded additional information about the inhabitants of the Tufano site. From the available data, it appears that the terrace was occupied intermittently for 4,000 years, but the primary component of the site relates to the late Middle Woodland period (Funk 1976). The principal occupation has been radiocarbon-dated using a charcoal sample from Feature 7, to within 100 years of A.D. 700 (Y-1382) (Figure 1). The former Hudson River channel ran approximately 30 feet from the site, along the eastern edge, and it is probable that "the Indians were attracted to the site by shallows which provided good fishing" (Funk 1976).

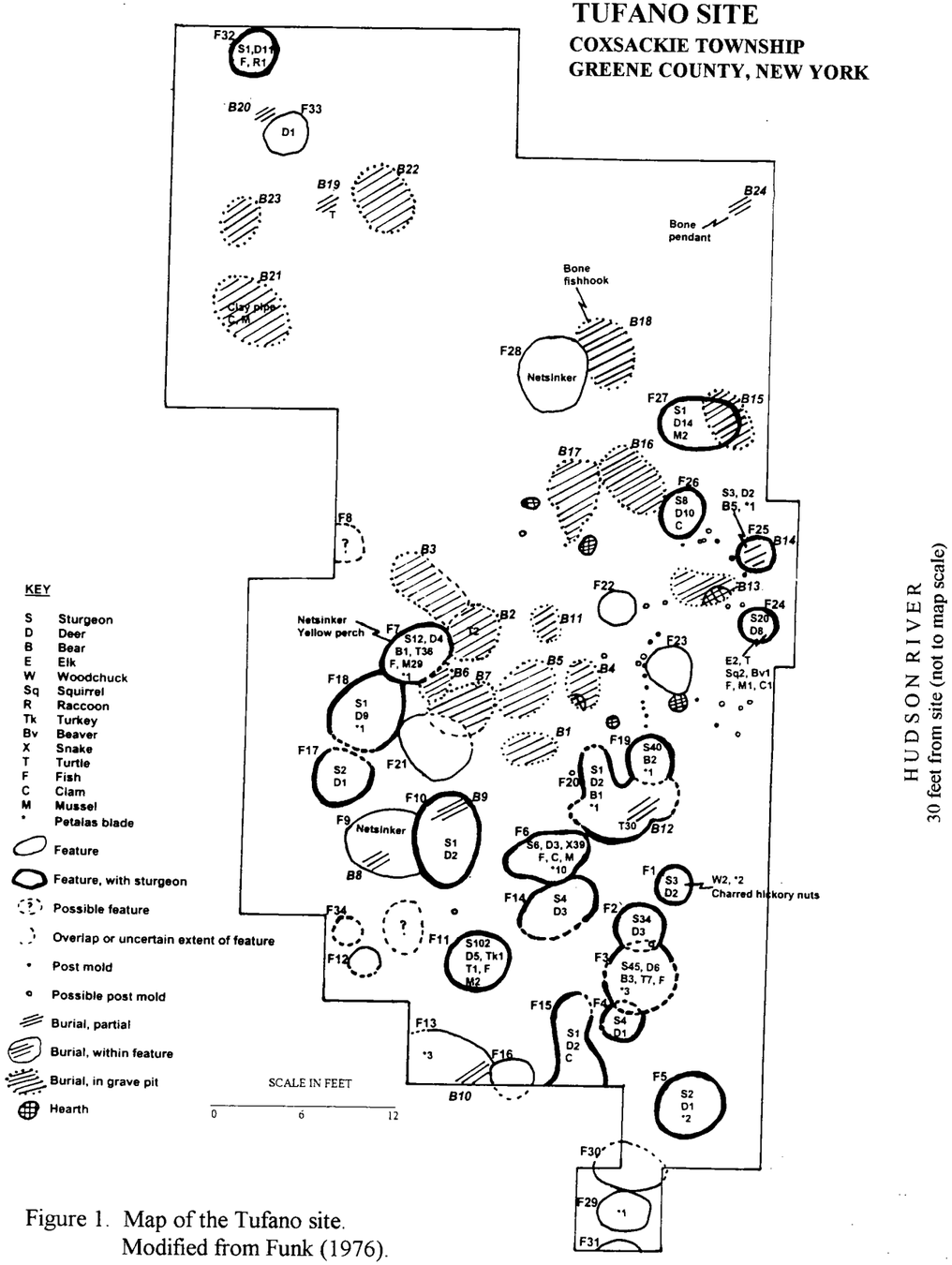

Figure 1. Map of the Tufano site. Modified from Funk (1976).

Tufano is unique among Hudson Valley sites because of its combination of numerous features and burials. The site includes 24 burials and 34 non-burial pit features. Among the faunal remains found at the site were "a mass of sturgeon plates" (Funk 1976). There were also numerous chert fragments of Petalas blades, which as a special form of knife, "may have served for the butchering and dressing of sea sturgeon" (Brumbach 1986). Funk (1976) introduces this possibility by stating that the tough sturgeon scutes (or scales) "would need to be removed prior to slicing off portions of the fish." Although Funk indicates that bifacial knives similar to Petalas blades were used by Northwest Coast Indians to cut up salmon, he also suggests their potential usefulness in the dressing of game (Funk 1976).

Petalas Blades

"Petalas blades can be generally described as large, broad, straight or round-based, relatively thin bifaces, with greatest breadth at or just above midpoint" (Figure 2) (Funk 1976). Funk named the unusually large blades after the Petalas site, where, in 1963, he first discovered them in abundance. This site, a workshop where Petalas blades, knives, and other stone tools were produced, is one mile away from the Tufano site on the upland above Fourmile point. When referring to the blades from Tufano, Funk (1976) determined that "nearly all the blades show wear along the edges, ranging from slight to heavy," but he rarely saw wear on the bases, which indicated they were used as knives. As such, Petalas blades could have been hafted or used in the hand (Funk 1976).

According to my research, Petalas blades or Petalas-like blades have been found at ten sites in the middle Hudson Valley (Table 1). At Tufano, 11 features contained a total of 26 Petalas blade fragments or blanks. At the Petalas site, 201 blades, blanks, and fragments were found, mostly on the surface Petalas blades have also been found at Black Rock, Bronck House Rockshelter, Dennis, Joy, and Westheimer sites. Possible Petalas blades have been found at Rocky Point and Barren Island (Funk 1976). Bifaces similar to

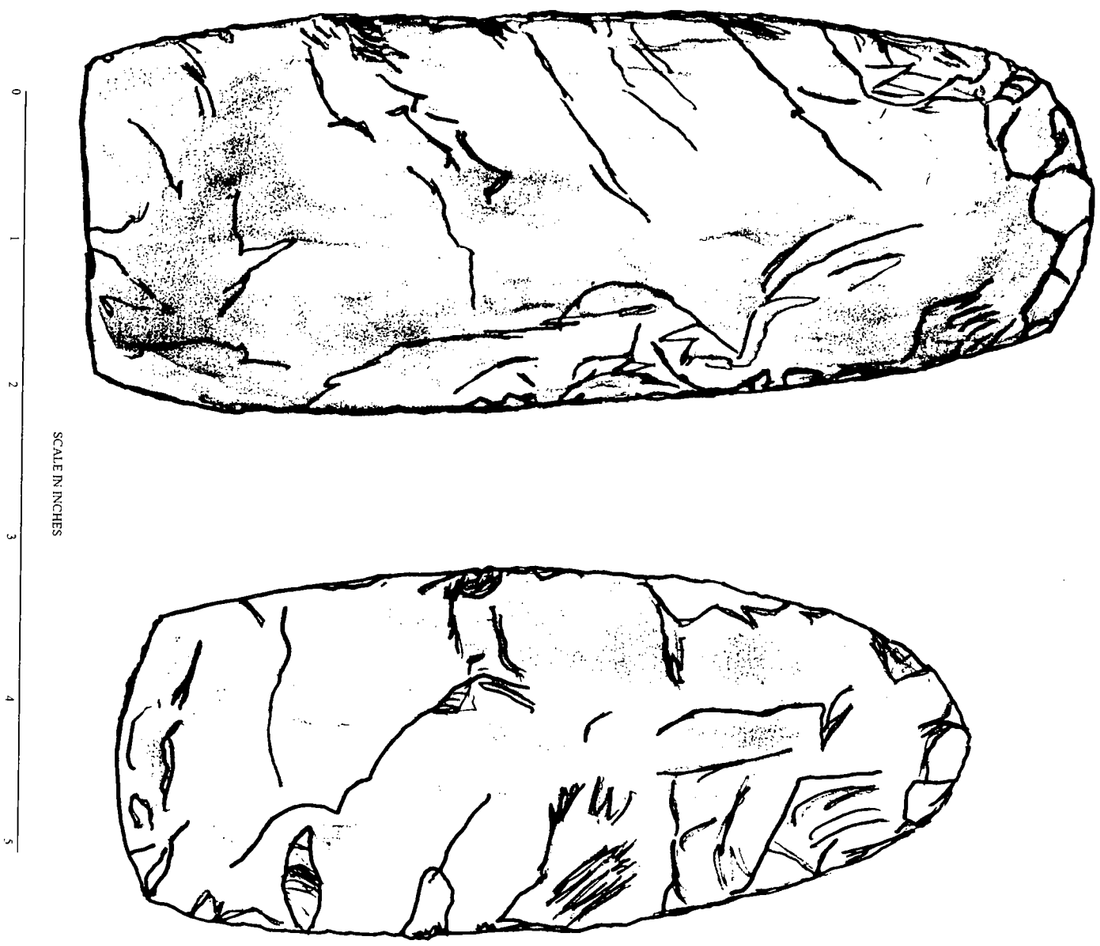

Figure 2. Petalas blades, Joy site, Albany County, New York. Sketched from Funk (1976).

Table 1. Middle Hudson Valley Archaeological Sites with Petalas Blades*

SITE	LOCATION	ASSOCIATED TIME PERIOD	FAUNAL REMAINS	REFERENCES
Barren Island	Near Coeymans, Albany Co. Just off west shore of Hudson River.	Middle Woodland	sturgeon, deer, clams, other mammals	Funk 1976:46-60
Black Rock	Athens, Greene Co. Hudson River can be seen from the site.	late Middle Woodland A.D. 850 ± 95 (I-3444)	sturgeon, deer, fish other mammals	Funk 1976:90-97
Bronck House Rockshelter	Coxsackie, Greene Co. 3 miles from Hudson River.	Association unknown (primary occupations Middle Woodland and Late Woodland)	sturgeon, deer, mussels	Funk 1976:98-105
Dennis	Menands, Albany Co. Little River, branch of Hudson.	Middle Woodland A.D. 630 ± 65 (Dic-185) Late Woodland	sturgeon, deer, mussels	Funk 1976:29-42
Joy	Menands, Albany Co. Little River, branch of Hudson.	Middle Woodland/ association with Dennis	none	Funk 1963b
LSR**	Near Hudson, Columbia County	**	**	Funk 1976:65
Petalas***	Coxsackie, Greene Co. Elevated above the Huson River.	late Middle Woodland/ association with Tufano	none	Funk 1976:64-69
Rocky Point	Saugerties, Ulster Co. At juncture of Esopus Creek and Hudson River.	late Middle Woodland	sturgeon, deer, clams	Funk 1976:136-140
Tufano	Coxsackie, Greene Co. Former bank of Hudson River.	late Middle Woodland A.D. 700 ± 100(Y-1382)	sturgeon, deer, mussels, clams, fish, other mammals	Funk 1976:70-89
Westheimer	Schoharie, Schoharie Co. Schoharie Creek	Middle Woodland A.D. 410 ± 80(Y-2350) A.D. 450 ± 80(Y-2349)	deer, other mammals	Ritchie and Funk 1973: 123-142

* includes possible Petalas blades.

** surface site.

*** predominantly a surface site, only two concentrations excavated.

Petalas blades have been recovered by Kenneth Mynter, an avocational archaeologist, from the surface near Hudson, New York, at a site known as LSR (Funk 1976). Petalas blades first appear in the archaeological record during Middle Woodland times, at around A.D. 410.

Tufano and Petalas have been tentatively designated as sites of the Fourmile phase. This phase seems to have been localized to the Greene County area and dated at about A.D. 700 (Funk 1976). Petalas blades, an important trait of the Fourmile phase, have not been found in the archaeological record after A.D. 850 (Funk 1976).

Sturgeon

Acipenseriformes, the ancient order of fishes to which sturgeon belong, first made their appearance between 144-213 million years ago (Bouton 1994; Stegemann 1994). "Rare fossil-finds indicate that the genus for sturgeon (*Acipenser*) dates from the Upper Cretaceous period, 65 million years ago" (Bouton 1994). Sturgeon are "living fossils", and are classified as bony fishes, although they are primarily cartilaginous. Sturgeon possess five rows of bony plates, or scutes, and are evolutionarily placed somewhere between sharks and bony fishes (Forrist 1996; Stickerberger 1996). The two species that occur in the Hudson River are the shortnose, *Acipenser brevirostrum*, and the Atlantic, *Acipenser oxyrinchus* (Forist 1996).

Sturgeon are benthic feeders that subsist mainly on crustaceans, bivalves, and worms (Friedland 1998). "They use their snouts and barbels to root around in bottom sediments, vacuuming up organisms with their soft mouths" (Reshetiloff 1995:19-20). Sturgeon may live up to 60 years, and reach sexual maturity relatively late in life (Forist 1996; Reshetiloff 1995). The shortnose sturgeon is one of the smallest members of the genus *Acipenser* with a maximum size of 3.5 feet and weight of 20-25 pounds (Forist 1996; Smith 1985). According to Forist (1996), the "Atlantic sturgeon is the largest fish

of the Hudson estuary, sometimes achieving a length of 14 feet and a weight of 800 pounds."

Atlantic sturgeon are anadromous, which means that they migrate from the sea up a river to spawn. Mature males do not return to the Hudson to spawn until they are at least 12 years old, and mature females do not return until they are approximately 18 years old (Forist 1996; Smith 1985). Just-mature males and females weigh, respectively, approximately 100 and 72 pounds (Forist 1996; Smith 1985). Mature Atlantic sturgeon enter the river in April or May to spawn and can sometimes be found as far north as Albany, but spawn mainly between Hyde Park and Catskill (Forist 1996; Smith 1985). Atlantic adults return to the ocean by fall, while the young remain in the estuary for a number of years (Forist 1996). By their sixth fall, most immature Atlantic sturgeon migrate out to sea (Smith 1985). Shortnose sturgeon remain within the estuary and spawn between Coeymans and Troy (Forist 1996). Where both species occur, the shortnose tends to spawn earlier than the Atlantic (Friedland 1998).

The massive migrations of sturgeons and other spawning fishes, which occurred well into the historic era, provided inhabitants with a valuable food resource (Brumbach 1986). Rostlund (1952) remarks that "Indian sturgeon fishing appears to have been important and conspicuous enough to have impressed the early visitors and standardized enough so that their reports indicate a widespread, nearly uniform method of taking sturgeon." The most common methods of taking sturgeon for Native Americans on the east coast were by net or spear. Native Americans in the middle Atlantic area additionally used weirs and seines (Kraft 1986).

Rostlund (1952) states that reports from early fisheries and Canadian fur traders "show that sturgeon were once common and in some waters even abundant." During the early part of the nineteenth century, "riverside dwellers stacked sturgeon carcasses as windbreaks and burned them like cordwood" and "Hudson River beer joints were fabled for serving caviar, because it was a cheap alternative to peanuts" (Lee 1994). By the end

of the century, the economic potential of this resource was realized, and a large commercial sturgeon fishing industry, specifically for their roe, or caviar, prospered (Lee 1994). Other parts of the sturgeon were also utilized. The meat was smoked and eaten, and the air bladders were used to make a clear gelatin called insinglass (Reshetiloff 1995).

Because no effort was taken during the early historic era by commercial fisherman to distinguish in their accounts which species, Atlantic or shortnose, were taken from the Hudson River, differentiation between species utilization in the past is not possible (Estuarine Study Group 1977). Landings of what is believed to have been a mix of Atlantic and shortnose sturgeon from the Hudson River around the turn of the century were seven million pounds a year. By the early 1900's, as a result of overexploitation, only incidental landings were reported (Friedland 1998). In 1913, total sturgeon landings were 20,950 pounds, and in 1963, 3,200 pounds (New York State, Division of Fish and Game:1966).

Unregulated harvesting, loss of habitat, mainly through the construction of dams, and pollution are cited as reasons for the decline in sturgeon populations (Smith and Clugston 1997). Waldman and Wirgin (1998) caution, "as a group, the approximately two dozen extant sturgeons of the world are severely threatened." Both species of Hudson River sturgeon are managed through fishery restrictions or through placement on the endangered species list (Smith and Clugston 1997). A plan under the Atlantic States Marine Fisheries Commission (ASMFC) manages Atlantic sturgeon in conjunction with state regulations. The shortnose sturgeon is protected under the Endangered Species Act, although, Friedland (1998) remarks generally that "a number of populations may be large enough to allow reclassification of their status."

Archaeological Evidence of Sturgeon

Due to their primarily cartilaginous nature, and the fact that cartilage does not preserve well, the primary evidence of these fishes found at archaeological sites are the bony scutes (Casteel 1976). These scutes have "an outer enamel layer made up of a distinct substance called ganoine" (Bouton 1994). In the five rows of scutes possessed by sturgeon, the Atlantic have a maximum number of 92 scutes, the shortnose, 95 (calculated from Smith 1985). I was unable to locate any research relating to microscopic differences between the scutes of *Acipenser oxyrinchus* and *Acipenser brevirostrum*, which would have allowed for differentiation in species at Tufano. Larger scutes can be ruled out as having come from a shortnose sturgeon. Smaller scutes could have come from either a juvenile Atlantic or a shortnose sturgeon. Tom Lake and C. Lavett Smith attempted to identify gross differences between the scutes of the two species of Hudson River sturgeon, but were unable to do so (Lake, personal communication:1999). Macroscopically, there does not appear to be any difference amongst the scutes in the Tufano collection.

Identification of the other faunal remains at the Tufano site, and their categorizing as terrestrial or aquatic, was also an objective of my research. Classifying the remains would allow for evaluation of the contribution made by Hudson River resources to the prehistoric diet of the Tufano inhabitants. According to Funk (1993), all the archaeological sites with sturgeon remains in New York State (north of Long Island) "are in the Hudson [River] Valley or [its] major tributaries." Sturgeon are also the most frequently found fish species at archaeological sites in this area (Funk 1993).

Information regarding 16 archaeological sites in the middle Hudson Valley with sturgeon remains are outlined in Table 2. These sites occur in Albany, Columbia, Dutchess, Greene, Rensselaer, and Ulster Counties. Of the sites with data available regarding quantity of scutes, Tufano, Black Rock, Rocky Point, and Hurley have the greatest number.

Table 2. Middle Hudson Valley Archaeological Sites with Sturgeon Remains*

SITE	LOCATION	STURGEON REMAINS	Occupation Associated with Sturgeon Remains	PETALAS BLADES	REFERENCE
Barren Island	Near Coeymans, Albany Co. Just off west shore of Hudson River.	present	Middle Woodland	possible (Funk 1976:294)	Funk 1976:46-60
Black Rock	Athens, Greene Co. Hudson River can be seen from the site.	188 scutes	late Middle Woodland A.D. 850 ± 95 (I-3444)	one plus three possible fragmentary	Funk 1976:90-97
Bronck House Rockshelter	Coxsackie, Greene Co. 3 miles from Hudson River.	four fragments	Association unknown (primary occupations Middle Woodland and Late Woodland)	one	Funk 1976:98-105
Dennis	Menands, Albany Co. Little River, branch of Hudson.	present	Middle Woodland A.D. 630 ± 65 (Dic-185) Late Woodland	one	Funk 1976:29-42
Fish Club Cave	Coeymans, Albany Co. 3 miles from Hudson River.	one scute	Association unknown (Archaic and Middle Woodland components)	absent	Funk 1976:61-63
Ford	Germantown, Columbia Co. Confluence of Roeliff Jansen Kill and Hudson River.	present	Association unknown (primary occupation middle Middle Woodland)	absent	Funk 1976:124-132
Goat Island Rockshelter	Red Hook, Dutchess Co. Off the east shore of Hudson River.	one scute 17 fragments	Association unknown (primary occupation Middle Woodland)	absent	Chilton 1994
Goldkrest	East Greenbush, Rensselaer Co. On Kuyper Island in floodplain of Hudson River.	present	Association unknown (early Middle Woodland and Late Woodland/Historic)	absent	Lavin et al.1996:113-130

Table 2. Middle Hudson Valley Archaeological Sites with Sturgeon Remains* (continued)

SITE	LOCATION	STURGEON REMAINS	Occupation Associated with Sturgeon Remains	PETALAS BLADES	REFERENCE
Hendrickson	Kingston, Ulster Co. At confluence of Hudson River and Rondout Creek	present	Association unknown (Archaic to Late Woodland occupations)	absent	Eisenberg 1989:21-53
Hurley ** ***	Hurley, Ulster Co. East shore of Esopus Creek.	present ****	Association unknown (Archaic and early Late Woodland components)	absent	Funk 1976:146
Menands Bridge	Menands, Albany Co. Little River, branch of Hudson.	present	Association unknown (Late Archaic,Transitional, Early, Middle, and Late Woodland)	absent	Funk 1976:43-45
Rocky Point	Saugerties, Ulster Co. At juncture of Esopus Creek and Hudson River.	present 28% of bone refuse	late Middle Woodland	possible (Funk 1976:139)	Funk 1976:136-140
Rural Cemetery **	New Paltz, Ulster Co. At bend of the Walkill River.	present	Association unknown (Archaic and Late Woodland components)	absent	Funk 1976:147
Tamarack	Wappingers Falls, Dutchess Co. Elevated above Hudson River.	present	early Middle Woodland A.D. 100 ± 170 (GX-10853)	absent	Vargo and Vargo 1986:1-18
Tufano	Coxsackie, Greene Co. Former bank of Hudson River.	254 scutes	late Middle Woodland A.D. 700 ±100 (Y-1382)	26 fragments or blanks	Funk 1976:70-89
Wolfersteig	Hurley, Ulster Co. Terrace overlooking Esopus Creek.	present	early Late Woodland	absent	Smith et al. 1994:1-5

* not a complete list, includes nearly all the important sites as well as some less well known ones.
** excavated by the late James Burgraff.
*** formal site report not available, artifacts being catalogued at the New York State Museum.
**** observed by me to be greater in number than the scutes from the Tufano site.

According to my research, the earliest dated feature in which sturgeon remains have been found is at the Tamarack site. The pit containing the sturgeon remains has been dated (GX-10853) to the early Middle Woodland time period, to within 170 years of A.D. 100 (Vargo and Vargo 1986).

Two sites in the middle Hudson Valley, Barren Island and Dennis, contained sturgeon remains in Middle Woodland features. According to Funk (1976), the Barren Island site was occupied for over 4,500 years. Although relatively little bone refuse was found at Barren Island, sturgeon remains were important in Middle Woodland levels (Funk 1976). Most of the sturgeon remains at Dennis were also found in the Middle Woodland level, although some were found in the Late Woodland level. One feature at Dennis was radiocarbon dated (Dic-185), using charcoal from the Middle Woodland level, to within 65 years of A.D. 630 (Funk 1976).

The sturgeon remains at Black Rock, Rocky Point, and Tufano have been dated to the late Middle Woodland time period. At Black Rock, 188 sturgeon scutes were found. "The collection from both pits and midden at Black Rock pertains almost exclusively to a late Middle Woodland occupation" (Funk 1976). A charcoal sample from Feature 2 yielded a radiocarbon date (I-3444) to within 95 years of A.D. 850 (Funk 1976). Funk (1976) felt that the primary occupation at Rocky Point was during late Middle Woodland times based on "the pottery styles, taken in conjunction with the Levanna and Jack's Reef Corner-Notched points, the Petalas-like blade, the sinewstone, and the bone bangle." Approximately 50 of the 180 bone fragments found at the site were those of sturgeon (Funk 1976). Tufano, as previously stated, also dates within the late Middle Woodland time period. These three sites are among the four sites in the middle Hudson Valley with the greatest number of sturgeon remains. The fourth site, Hurley, has yet to be formally analyzed.

Although the Wolfersteig site has Archaic, Middle Woodland, and early Late Woodland components, the feature containing the sturgeon remains has been dated, based

on associated Castle Creek phase ceramics, to the early Late Woodland period at approximately A.D. 1275-1350 (Lake, personal communication 1999). From the available data, this appears to be the most recent middle Hudson Valley site with sturgeon remains.

Of the seven datable sturgeon sites, one is from the early Middle Woodland time period, two are from the Middle Woodland time period in general, three are from the late Middle Woodland period, and one is from early Late Woodland times.

The sturgeon remains found at the other nine sites in the middle Hudson Valley have not been attributed to a specific occupation. It is possible that the sturgeon remains from these nine sites could be attributed to the time span from early Middle Woodland to Late Woodland times as each site has occupations which fit into this time span. Three of these sites have primary occupations dated to the Middle Woodland time period in general, although one also has an Archaic component, and one has a Late Woodland component. Another site was occupied primarily during the middle of the Middle Woodland period. One site has primary occupations during the early Middle Woodland and the Late Woodland/Historic periods. Another site has occupations that span successively from Late Archaic to Late Woodland times. The remaining three sites have occupations during the Late Woodland period, but also have prior occupations which date back to Archaic times.

Earlier sites may exist in upstate New York which have the remains of sturgeon. In fact, other aquatic remains have been found on earlier sites (e.g., the Late Archaic Lamoka Lake site near Ithaca in central New York [Ritchie 1969]).

In contrast to preceding time periods, the archaeological record relating to the Middle Woodland period indicates an increasing tendency to stay in one place for longer periods of time. Funk (1976) remarked that, aside from the apparent increased sedentism, there was little change during the Middle Woodland phase, "except perhaps for a growing reliance on sturgeon, other fish, and molluscs in the Hudson Valley." This study begins to

resolve the uncertainty expressed in Funk's comment regarding the use of aquatic resources by Native Americans along the middle Hudson River.

METHODS

The New York State Museum in Albany provided access to the Tufano Collection. I identified the faunal remains by using the Museum's comparative collection. Joseph Bopp of the New York State Biological Survey helped identify difficult specimens. Dr. Robert E. Daniels, also of the Biological Survey, helped identify a partial fish scale that I found in soil residue from the site.

Methods of calculation I used were number of individual specimens per taxon (NISP), minimum number of individuals (MNI), and estimated meat in pounds (EM). NISP is determined by counting each single element, such as a bone or tooth, that can be assigned to a specific species (Grayson 1984). MNI is "determined by counting the most frequent side of the most frequent skeletal element of each taxon" (Fagan 1996). Size differences as well as age indicators are often taken into account when using this calculation method. These observations can adjust the number upward or downward. EM was calculated by multiplying MNI times the average weight or estimated meat in pounds of species represented. All three calculation methods were done site-wide as opposed to per stratum, feature, or cluster, although almost all specimens came from features.

Since it was not possible to determine species of sturgeon from the scutes, data regarding Atlantic sturgeon were used in my calculations. Because I was unable to locate research which correlates size of scute to size of sturgeon, the average weight of a just-mature Atlantic female spawner (72 lbs.) was used to estimate meat in pounds for sturgeon (Smith 1985). Just-mature males weigh 100 lbs. Meat in pounds for other faunal remains was estimated using comparable data from Ritchie's (1969) faunal analysis of the Kipp Island site. Since a number of the original whole sturgeon scutes were now in fragments at the Museum, my tally of 291 was not used. Instead, Funk's (1963a and

1964) whole scute count of 254 was used to calculate MNI and EM. C. Lavett Smith's (1985) data on Atlantic sturgeon scute counts for dorsal, ventral, and lateral rows were used to determine maximum number of scutes per sturgeon, which was divided into Funk's total. Items, such as bones and clam shells, which were listed in Funk's (1963a and 1964) notes, but not found in the collection, were used in some calculations and noted as such.

Non-sturgeon fish remains were found in six features at Tufano and typically consisted of small bones mixed in with soil from the site. I viewed the soil under the microscope and was able to locate one partial fish scale. I felt that soil flotation would be necessary in order to more easily locate additional scales to aid in the identification of the fish remains. The Museum believed that this method would be too destructive, so further attempts to identify the fish remains from these features were not made.

General problems exist with all the calculation methods I used, and each of the methods are affected by a number of factors. I will not address all of the factors, but only those I feel are most relevant to the analysis of the faunal remains at Tufano. Thus, when calculating NISP, differences in specimen counts per taxon "may simply reflect the fact that some animals were retrieved from kill sites whole, while others were butchered on the spot" (Grayson 1984). Use of NISP does not address the question of meat weight which is often of greater importance than counting individual bones when examining prehistoric subsistence patterns. In addition, "preservation differentially affects the bones of different taxa" (Grayson 1984).

Differential preservation is also a factor when calculating MNI. Since I calculated MNI on the Tufano site as a whole, Grayson (1984) would feel the result represents "the smallest possible minimum number values." Other possible ways to view the faunal assemblage at the Tufano site would have been by stratum, feature, or cluster (Grayson 1984). Detailed information regarding the location of faunal remains by stratum within each feature was not provided through the New York State Museum's data, making

calculation of MNI by this method difficult. On the other hand, counting individual features where a taxon was present, I felt, would have resulted in an overestimate of both MNI and EM because a number of the features at Tufano contained only one or two elements of a taxon. The features at Tufano were close enough to each other such that remains of one animal could have been distributed in several features. Assessment by clusters of features, a determination that I did not attempt, would need better association of artifacts before that method of calculation could be used. Although one basic method of determining clusters is through the apparent visual association of features at the site, convincing methods would include the analysis of lithic and/or ceramic materials in individual features to find items that fit together or conjoin. By use of these more detailed and time-consuming methods, it would be possible to more accurately define clusters.

The primary problem with the calculation of EM is that it is based entirely on the calculation of MNI. Since MNI can be calculated in a number of ways, its definition directly affects EM. Specific to the Tufano site, I calculated EM for the sturgeon remains based on the weight of a just-mature Atlantic female spawner. Since no data exists to differentiate between species or sex from the scutes, I chose this figure to stand for sturgeon, but some of the scutes could have come from a much smaller shortnose. If this were the case, I would have overcalculated EM. In contrast, Atlantic sturgeon can weigh up to 800 pounds. Since no data are available which correlates size of scute to size of sturgeon, I used the figure of 72 pounds. By doing this, EM could have been undercalculated. I based EM for the other faunal remains found at the site on the average meat in pounds for each individual specimen per taxon, and did not, except in the case of bear remains, take into account the possibility of larger or smaller specimens.

RESULTS

The data from my research are summarized in four tables and one map. Figure 1 is a site map of Tufano with features, in bold, that contain sturgeon. Included in the map is a key to all faunal remains. Numbers following the key designations refer to the number of elements per taxon. The purpose of the map, in addition to pointing out the location of various fishing-related items and faunal remains, is to provide a visual display from which to make observations about site usage. Table 1 is a listing of middle Hudson Valley archaeological sites where Petalas or Petalas-like blades have been found. Table 2 shows middle Hudson Valley archaeological sites where sturgeon remains have been found. Table 3 consists of the identification of the faunal remains from Tufano with numbers of elements per taxon. This table also contains the calculations for NISP, MNI, and EM. Table 4 shows the top four rankings per calculation method used in Table 3, and includes designation of those faunal remains as aquatic/semi-aquatic or terrestrial.

Table 3. Identification of Tufano Faunal Remains

Class	Common Name	Species	NISP	Rank	MNI	Rank	EM	Rank
Mammals	Deer	*Odocoileus virginianus*	89	2	3	2	300	2
	Elk	*Cervus canadensis*	2	8	1	8	400	1
	Bear	*Ursus americanus*	12	7	2*	4	300	2
	Woodchuck	*Marmota monax*	2	8	1	8	2	8
	Squirrel	*Rodenta sciuridae*	2	8	1	8	2	8
	Raccoon	*Procyon lotor*	1	11	1	8	10	5
	Beaver	*Castor canadensis*	1	11	1	8	10	5
Birds	Turkey	*Meleagris gallopavo*	1	11	1	7	5	7
Reptiles	Eastern Box Turtle	*Terrapene carolina*	43	3	2	4	NA	
	Wood Turtle	*Clemmys insculpta*	37	6	2	4	NA	
	Snake	*Serpentes sp.*	39	5	1	8	NA	
Fish	Sturgeon	*Acipenser sp.*	292 (254**)	1	3	2	216	4
	Yellow Perch	*Perca flavescens****	1	11	1	8	NA	
	Fish	present, unidentified	NR					
Shellfish	Clam	*Mercenaria sp. ****(1**)*	39+	4	39+	1	NA	
	Mussel	*Unionidae sp. (35**)*						
Totals	Identified Species	15	561+		59		1245	

* 1 adult, 1 juvenile.
** as identified and as counted by Funk (1963a and 1964).
*** probable (Daniels, personal communication; 1999).
**** feature 15 clamshell lens not saved (Funk 1963a and 1964).
NA not available.
NR not recorded.
NISP number of individual specimens per taxon.
MNI minimum number of individuals.
EM estimated meat in pounds.

Table 4. Top Rankings by Calculation Method

Rank	NISP	Type	Rank	MNI	Type	Rank	EM	Type
1	Sturgeon	A	1	Shellfish	A	1	Elk	T
2	Deer	T	2	Sturgeon	A	2	Bear	T
3	Eastern Box Turtle	T	2	Deer	T	2	Deer	T
4	Shellfish	A	4	Turtle sp.	T and A	4	Sturgeon	A

Type Key
A aquatic/semi-aquatic
T terrestrial

DISCUSSION

Tufano was occupied over a long span of prehistory, but its primary component has been attributed to the Fourmile phase of the late Middle Woodland time period (Funk 1976). Placement in this time period is based on projectile points and pottery found in the burial and non-burial pits at Tufano. Thirty-two of the features with temporally diagnostic artifacts can be attributed to this complex (Funk 1976). Projectile points in two features suggest earlier occupations; one contained Petalas blade bases, however, and the points in the other, while stemmed, could not be definitely assigned to a type.

There are four major usages for the pits that constitute the 34 non-burial features at Tufano. These pits were used for storage, processing, cooking, and/or refuse. Pits were frequently used for one purpose, and then re-used for another.

According to Funk (1976), storage pits such as those found at Tufano "first appeared spasmodically in Fox Creek times, becoming common features in the later stages of development exemplified by the Dennis and Tufano sites." Often, when the food in storage pits was removed, it was practical to re-use the pits for refuse or food processing (Moeller 1992). Although Moeller writes about Late Woodland features, the same principles would probably have applied to late Middle Woodland features. Long-term storage pits, like those found at Tufano (Funk 1976), may have been used to store nuts and acorns.

Food storage pits were sometimes used only for short-term storage in order to keep scavenging animals, such as raccoons and bears, away from the food being processed (Moeller 1992). Moeller (1992) believes that "empty or nearly culturally sterile pits served only for a short time as food storage pits." Features 30 and 31 at Tufano were culturally sterile pits, and a number of other features contained only a few artifacts (Figure 1). Funk (1976) proposed that some of the pits at Tufano might have been used to store fish until they were partly decayed: "Some Indian groups prized the taste of 'ripe' fish, including the northern Iroquoians."

In addition, storage pits (or cache pits), were sometimes used to store tools. Funk (1963b) believes this was the case for the five complete Petalas blades and one fragmentary Petalas blade found at the Joy site (Figure 2). Since the Joy site is just west of the Dennis site, Funk (1963b) felt it likely that the Joy cache pit was related to the Middle Woodland component at Dennis. Nine of the 23 Petalas blades from the Westheimer site were also found in a cache in a post mold.

Cooking features, typically evidenced by fire-cracked rock and charcoal, were sometimes "repeatedly used and then filled up" (Funk 1976). Some of the items which made their way into refuse pits were "the organic by-products of food processing" (Moeller 1992). Among these by-products would have been bones, skin, entrails, shells, and charcoal. Also often found in refuse pits is debitage, or the stone refuse from making stone tools, as well as "expended, non-repairable, broken, and heavy processing implements" (Moeller 1992).

According to Funk (1976), the contents of Feature 4 indicated that it was probably first used for storage and was later filled with hearth sweepings. Feature 7, which had several stratified layers containing "ash, charcoal flecks, mammal and fish bones, and firestones", may have been a cooking feature or perhaps a refuse pit for the sweepings of nearby hearths and house floors (Funk 1976).

Two features toward the southern portion of the site, 3 and 11, contained the largest number of sturgeon scutes (Figure 1). Feature 3 contained a lens of chert flakes, among which were three Petalas blade fragments, as well as 45 sturgeon scutes and charcoal (Funk 1976; 1963a and 1964). Feature 11, with 102, contained the greater number of scutes per feature at Tufano (Funk 1963a and 1964).

The site map (Figure 1), in conjunction with Funk's notes from 1963 and 1964, provides some information regarding seasonality and successive occupations at Tufano. Whether it was originally a burial site or habitation is not clear, although it obviously served both purposes at one time or another. Typically, the burials at Tufano were in

"shallow, oval fossae" (Funk 1976). Under Burials 4 and 13 are hearths, which would suggest occupation prior to interment. Where some pit features intrude upon graves, however, the burials must have come before the pits.

Three or four interments, Burials 8, 9, 10, and possibly 12, occur in refuse pits. It is interesting to note that Burials 8 through 11 were also the deepest at the site. From this information, one might assume that the already dug refuse pits were utilized for graves during colder months when the unbroken ground elsewhere might have been too hard to dig.

The two lines of post molds near the eastern portion of the site indicate that at least one protective structure of some type existed on the site. This would also suggest occupation during colder months. A hearth was found within the curve of the longest line of post molds.

Seasonal occupation can also be inferred from the faunal remains and charred hickory nuts found at Tufano (Figure 1). The presence of sturgeon suggests occupation during the spring and summer. The charred hickory nuts suggest a fall occupancy. If one were to assume that the burials in refuse pits occurred during winter months, the site could have been inhabited throughout the year. According to Funk (1976), it is possible "that the sometimes deep pits were employed for the storage of plant foods as insurance against winter scarcity." Although he considered a year-round habitation possible, Funk thought that it would have been "on a sporadic and intermittent basis" (1976) rather than continuously.

The identification and analysis of faunal remains provides some insight into the subsistence patterns of the occupants of Tufano (Tables 3 and 4). Of the 15 species of fauna represented, seven are aquatic or semi-aquatic. The top rankings by calculation method show an even distribution for aquatic and terrestrial species for NISP and MNI, but terrestrial species provided the greatest portion of EM. Only deer and sturgeon appear in the top four rankings of all three calculation methods, supporting Funk's (1976)

hypothesis that sturgeon and deer were the two most important sources of animal protein at the site.

The MNI for deer, from 89 elements of this taxon, was calculated by identifying two pairs of astragali (left and right) as well as two astragali which I was unable to assign to side. This gave the figure of three MNI. Although I was unable to obtain information on the total bones in a skeleton of a white-tailed deer, I was able to find the number for fallow deer. The difference between the two species of deer would not be significant. The fallow deer skeleton contains 210 bones (Whitehead 1993). MNI for deer was, therefore, based on having approximately 14 percent of the three deer skeletons.

MNI for sturgeon was calculated using the maximum number of scutes for an Atlantic sturgeon, which is 92. I used Funk's count of 254 whole sturgeon scutes. Simple division gave a minimum number of three sturgeon. The largest scute in the Tufano collection measured approximately 107 x 105 millimeters. Based on the size of this scute, at least one of the three sturgeon was an Atlantic. Using Funk's tally, the MNI of three sturgeon was based on having approximately 92 percent of the scutes.

According to Carbone and Keel (1985), materials resistant to decomposition are those made up of structural elements such as bone, antler, teeth, and shell. Since sturgeon scutes have an enamel layer, they would fit, along with mammal bones, into the resistant class of materials. This suggests that sturgeon scutes and mammal bones are similar in their decomposition rates, which might have resulted in sturgeon being underrepresented in my calculations.

One must also take into account that of the features containing deer remains, none contained over 14 elements. In addition, a majority of the remains of deer came from the legs of the animal. These factors could indicate that a separate deer butchering area existed which was not located in the excavations done at Tufano.

A partial fish scale, possibly from *Perca flavescens*, was found in Feature 7. I made a preliminary identification of this scale using the manual by Daniels (1996). Since

the portion of the scale remaining was approximately one-fifth of the entire scale, Daniels (personal communication 1999) identified it as the "probable scale of a yellow perch." According to Rostlund (1952), species of the perch family were less important to Native Americans than many other fish. Yellow perch remains have also been found at the Goat Island Rockshelter, Lamoka Lake, and Wolfersteig sites (Chilton 1994; Ritchie 1965; Smith et al. 1994). Walleye pike, another member of the perch family, is common at archaeological sites in New York State (Funk 1993; Smith 1985). Thus, it is possible that perch were an important food source. Additional fish remains were found in six features at Tufano, but for the reasons previously stated, I was unable to identify them.

Fishing implements were not abundant in comparison to points and knives at the site. Two netsinkers and a plummet were found in the plow zone. Another three netsinkers were located, one each, in Features 7, 9, and 28 (Figure 1). One bone fishhook was found within Burial 18.

In some features, faunal remains were found in conjunction with Petalas blades. For ease of discussion, Petalas blades will be used to refer to whole blades as well as fragments, unless otherwise noted. Of the 11 features containing Petalas blades at Tufano, only one feature contained sturgeon but not deer. Eight contained the remains of deer and sturgeon. Of these, one also contained the remains of bear. The two remaining features with Petalas blades had no faunal remains. Of the 15 features and possible features without sturgeon remains, 14 had no faunal remains of any kind. It is possible that these features were used for short-term storage. Feature 11, which had by far the greatest number of sturgeon remains, contained no Petalas blades, but these tools were found in three adjacent pits.

Data retrieved from the Tufano site regarding Petalas blades cannot adequately establish that they were used for the butchering and dressing of sturgeon. Their appearance in the middle Hudson Valley seems to be restricted to the time span to which sturgeon remains are most frequently attributed (Tables 1 and 2). The data from Tufano

suggest an association between Petalas blades and both deer and sturgeon. This coincides with Funk's (1976) idea that Petalas blades could have been useful for dressing both deer and sturgeon. At the Davenport Creamery site on the Susquehanna River, where no sturgeon remains and one complete Petalas blade were found, it appeared that the wear pattern on the Petalas blade coincided "with the wear on meat knives...for the Russian Upper Paleolithic" (Funk 1972). The Petalas blade as a multi-purpose tool also seems to be suggested by its occurrence at sites such as the Davenport Creamery, Dennis, Barren Island, and Westheimer, with differing types of faunal assemblages.

Of the 16 middle Hudson Valley sites with sturgeon remains (Table 2), only four contained definite Petalas blades, although an additional two sites had possible Petalas blades. This lack of frequent association is probably not significant given the fragmentary nature of the archaeological record.

Of the ten middle Hudson Valley sites with Petalas or Petalas-like blades, sturgeon remains were present at six (Table 1). The four sites lacking archaeological evidence of sturgeon are LSR, Petalas, Joy, and Westheimer. Since the LSR site is only a surface site, no faunal remains would be expected. The lack of sturgeon remains at the Petalas site could be a result of the limited excavations there, and its definition as primarily a surface site. The Joy site, where Petalas blades were found in a storage pit, was also a limited site, and has a presumed association with Dennis (where sturgeon remains were found). The absence of sturgeon at the Westheimer site could be explained by its location on the Schoharie Creek, and its significant distance from the Hudson River.

The settlement pattern of Transitional groups (ca. 3000 B.P.) in the Hudson Valley points to a preference to dwell near the Hudson or its major tributaries in all times of the year (Funk 1976). This preference for riverside or riparian sites seems to have continued through to the Fourmile phase of the late Middle Woodland period, ca. 1250 B.P. During the Middle Woodland time period, the archaeological evidence also points to increased sedentism. The sedentary nature of the inhabitants at Tufano can be seen through the

indications of at least one shelter structure evidenced by post molds. In addition, the potential storage pits, faunal remains, and nuts found at Tufano suggest a possible year-round habitation. The burials might also indicate sedentism.

Since the Tufano site lies between the current spawning grounds of both species of Hudson River sturgeon, and is situated next to shallows of the Hudson River, the inhabitants probably used both nearby and more distant resources. Fish provide necessary calcium and protein, and are important sources of food energy (Styles 1994). Exploitation of anadromous fish, such as Atlantic sturgeon, "can shape socio-spatial organization and lead to changes in preexisting settlement-subsistence systems" (Brumbach 1986). "By harvesting anadromous and catadromous species, the human population is able to increase both total energy capture and feeding efficiency without increasing territory or mobility" (Brumbach 1986). Reliance on Hudson River sturgeon for subsistence could have led to the apparently increased sedentism seen at Tufano. With increased sedentism comes more complex sociopolitical formations (Smith 1989).

The shift to maize-centered agriculture across eastern North America was associated with more complex societies (Smith 1989). The shift to farming took place around A.D. 1000 in other parts of New York State. Toward the close of the Middle Woodland period in the Hudson Valley, storage pits "may have contained cultigens; e.g., corn"(Funk 1976). This would coincide with the date of approximately 1000 B.P. for cultigens in other parts of the state (Ritchie 1969).

It appears from the archaeological record, as charted in Table 2, that Hudson River sturgeon, as an important resource, were exploited more fully during the Middle Woodland period than in earlier phases. Its use appears to have continued into at least early Late Woodland times when agriculture definitely begins in New York.

CONCLUSIONS

This research demonstrates that sturgeon was an important resource to the Native Americans at the Tufano site. Other aquatic species which were identified among the faunal remains were beaver (*Castor canadensis*), one species of turtle (*Clemmys insculpta*), yellow perch (*Perca flavescens*), clams (*Mercenaria* sp.), and mussels (*Unionidae* sp.). It appears that the Hudson River made a substantial contribution to the diets of the inhabitants of Tufano. Although fishing-related implements were not numerous at the site, they offer additional testimony to Native American use of the middle Hudson River. No definite determination regarding the specific purpose of Petalas blades could be made, although there seems to be an association with both deer and sturgeon remains. Presently, one might infer a causal connection between the peak in sturgeon usage along the middle Hudson River in the late Middle Woodland period and the apparent restriction of Petalas blades to that period.

The terrestrial species found at Tufano included deer, bear, elk, woodchuck, squirrel, raccoon, and turkey. Although this research supports the contention that sturgeon was an important resource at Tufano, terrestrial species provided a greater proportion of estimated meat.

It seems likely that the site was inhabited for a majority of the year, and perhaps year-round. The utilization of middle Hudson River resources by late Middle Woodland groups, such as the inhabitants of Tufano, could have played a role in predisposing their descendants to agriculture a few centuries later.

RECOMMENDATIONS

My recommendations for future research related to the topics covered in this study are numerous. Among them is the need for research which investigates the possibility of microscopic differences between the scutes of the two sturgeon species that occur in the Hudson River. In addition, data correlating size of scute to size of sturgeon would be

beneficial. Results provided by these studies might allow for a more detailed analysis of prehistoric usage of distinct sturgeon species in the Hudson River, as well as a more accurate measurement of meat in pounds for individual specimens.

Because human remains exist at Tufano, it might be possible to perform isotope-based reconstructions that focus on human bone. These minimally destructive tests use carbon and nitrogen isotopes to determine the relative dietary contributions made by terrestrial and marine species (Bourque and Krueger 1994). These tests would provide a more accurate account of the contributions of terrestrial and aquatic species made to the diets of the inhabitants at Tufano.

A detailed analysis of faunal remains found in association with Petalas blades might provide a clearer view of the use(s) for which they were manufactured. A controversial analytical method, which has achieved some favorable results, is blood protein analysis. This method studies the almost invisible residue left on stone tools from butchering activities and can sometimes be used to determine the fauna on which they were utilized (Loy and Dixon 1998). Blood protein analysis would only be helpful in determining the use of Petalas blades if they were utilized as butchering tools or weapons. Experimental use-wear analysis would be another possible method to determine their purpose, and would not be restricted to their use on flesh. This method is based on the microscopic study of signs of alterations on tools due to their use (Lindner 1983). By determining their purpose, it might be possible to understand why Petalas blades disappear from the archaeological record.

Methods which would be helpful in determining pit clusters at Tufano would be lithic and pottery analysis. These methods could provide information regarding the association of individual features at the site.

To supplement this research into prehistoric utilization of Hudson River resources, detailed analysis of aquatic and terrestrial remains from other sites in the area ought to be undertaken. Flotation of the soil residues from the six features at Tufano containing fish

remains might be helpful in determining which fish species, in addition to yellow perch and sturgeon, were used by the inhabitants of the site.

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IMPACTS OF SCALE ON BREEDING BALD EAGLES, (*Haliaeetus leucocephalus*), ALONG THE HUDSON RIVER, NEW YORK

A Final Report of the Tibor T. Polgar Fellowship Program

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