Human Activities and Site Formation at Modern Lake Margin Foraging Camps in Kenya

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Interpretation of archaeological sites with predominantly freshwater fish and reptile remains has been impeded by lack of documentation of how humans process such vertebrates, of bone modifications resulting from such handling, and of physical characteristics of sites produced by these activities. We report on 19 contemporary foraging camps on the shore of Lake Turkana, Kenya, with the creation, abandonment, and resulting faunal assemblages of 7 of these more closely described. Variable processing activities created a range of site structures but cross-assemblage regularities in patterns of bone surface modification and element frequencies are perceptible. Most sites were very large, with special-purpose activity areas peripheral to the main residential area. Site structure and size depended mainly on specific subsistence activities carried out and features of the camp locale rather than upon the number of occupants or duration of occupation. Sites can be classified as base camps or as fish production camps, with consistent differences in site structure and bone assemblage characteristics.© 1999 Academic Press

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INTRODUCTION

Sites containing aquatic vertebrates are common in the later archaeological record of Eurasia, Africa, and the Americas (e.g., Barthelme 1981; Bleed 1992; Brewer 1991; Butler 1993; Casteel 1976; Colburn et al. 1991; Gautier and van Neer 1989; Koch 1995; Morales Muñiz 1993; Peters and von den Driesch 1993; Schalk 1977; Stewart 1989; van Neer 1986; Wing and Brown 1979). Most such sites derive from Mesolithic, Late Stone Age, or other late Pleistocene or Holocene settings and can be assumed to be associated with anatomically modern humans, among whom aquatic resource exploitation is uncontroversial. However, fish and reptile remains have been found in late Pliocene through to the Late Pleistocene African archaeological locales, including Senga 5A at Lake Rutanzige (Harris et al. 1990), sites at Olduvai Gorge (Auffenberg 1981; Leakey 1971), and Lake Turkana (Leakey et al. 1996). This has raised the question of whether premodern hominids were responsible for accumulating and commin-
gling them with remains of terrestrial vertebrates and artifacts at such sites. Clarifying this issue has been impeded by lack of knowledge of human acquisition and processing of freshwater vertebrates and of resulting modifications to their bones as well as of physical characteristics of aquatic foraging camps that might distinguish them from natural accumulations in similar environments.

One step toward understanding such archaeological sites is studying present-day aquatic foraging camps. This article reports on 19 such camps, 18 created by Dassanetch people on the northeastern side of Lake Turkana, Kenya, and one by Turkana fishers on the lake’s western side (Fig. 1). Sixteen were documented by Gifford-Gonzalez in the early 1970s (Gifford 1977) and represent the range of site types Dassanetch people were creating in one geomorphic zone during the study period (see Gifford 1978, 1980 on differences in site function relative to location). Two Dassanetch fishing camps (FC1, FC2) surveyed by Stewart (1989, 1991) in the late 1980s lay in or immediately adjacent to Gifford-Gonzalez’s survey area and provide detailed observations on fish bone modification. Analytic work on modifications and element frequencies in the fish (Stewart 1989, 1991; Stewart and Gifford-Gonzalez 1994) and reptile (Rybczynski et al. 1996) bone assemblages from the camps has been previously reported. This article describes the human activities, resulting spatial distributions, and assemblage structures at the camps.

Our combined data were gathered with differing research goals, limiting the range of analyses possible. At only a few sites did we directly observe the activities that produced patterning in the bone assemblages, while the preponderance of sites were created before our fieldwork. Nonetheless, we believe our observations, like the first ethnoarchaeological studies of mammal assemblages, can serve as a baseline against which to compare other contemporary and archaeological assemblages and as a departure point for developing more detailed actualistic research on fish and reptile exploitation.

We begin with background on the region and peoples who created the sites; on site location; and observed procurement, processing, consumption, and disposal of fish and reptiles. In an appendix we present detailed data on seven camps as illustrations of results of such activities in terms of site structure, bone element representation, and bone modification patterns. The next section discusses general patterning of evidence useful in distinguishing aquatic foraging camps archaeologically, with a brief comparative discussion of fish remains from Olduvai Gorge sites.

**CONTEXT OF THE STUDY**

Lake Turkana (formerly Rudolf) is a nonoutlet African rift lake approximately 265 km in length and averaging 80 m in depth, lying mainly in northern Kenya, with its northern end in southern Ethiopia (Fig. 1). The lake displays dynamic fluctuations in its level, with annual variations of 0.5–1.0 m in concert with seasonal runoff from the Ethiopian highlands, but its average annual level has varied around 20 m over the past 75 years (Beadle 1981) and has been in a regressive phase since the end of the 1960s (Butzer 1971). In the span from 1968 to 1988 covered in this article, the lake varied at least 1.5 m in level, subsiding from a high stand in the late 1960s to ever-lower levels through the 1970s and 1980s and exposing many hect-
ares along low-gradient littorals surveyed by Gifford-Gonzalez and Stewart.

During the study, larger terrestrial species in the littoral zone included lion (*Panthera leo*), leopard (*Panthera pardus*, restricted to tree-lined major ephemeral rivers), striped hyena (*Hyaena hyaena*), spotted hyena (*Crocuta crocuta*), aardwolf (*Proteles cristata*), black-backed jackal (*Canis mesomelas*), Egyptian mongoose (*Herpestes ichneumon*), topi (*Damaliscus lunatus*), Grant’s gazelle (*Gazella granti*), common zebra (*Equus burchelli*), hare (*Lepus capensis*), and ground squirrel (*Xerus rutilus*). The littoral was intermittently visited by desert-adapted Grevy’s zebra (*Equus grevyi*) and beisa oryx (*Oryx gazella beisa*), but the most common ungulates were the water-dependent topi, Grant’s gazelle, and common zebra. Common reptile species were freshwater terrapins (*Pelusios adansonii*), Nile softshell turtles (*Trionix triunguis*), and Nile crocodiles (*Crocodylus niloticus*). Lake Turkana supports a fish fauna of 33 genera, but only six inshore taxa regularly appeared in the inventories from human sites: Nile perch (*Lates niloticus*), which can weigh up to 200 kg; tilapia (*Oreochromis niloticus*); Nile catfish (*Clarias lazera*); tigerfish (*Synodontis schall*); labeo (*Labeo houri*); and the young of a deepwater catfish (*Bagrus bayad*).

**Ethnographic Background to the Site Sample**

Eighteen of the 19 camps surveyed in this study were created by Dassanetch people, pastoralist-cultivators who speak an Eastern Cushitic language and live from the lower Omo River valley in southern Ethiopia to the northeastern shores of Lake Turkana in Kenya (Almagor 1978; Butzer 1971; Carr 1977). During our field studies, most Dassanetch lived on products from their sheep, goats, and cattle, cultivated sorghum and legumes, wild plants, fish, and lake reptiles. In times of drought, the Dassanetch received no food aid from national governments or nongovernmental organizations.

Some Dassanetch lacked livestock and were called *gal dies*, or “fisherman” by others in their tribe, a term denoting low social status (Gifford 1977, 1978). *Gal dies* lived in their own settlement just north of the international border, where they practiced intensive cultivation. In the early 1970s, *gal dies* men ranged along some 80 km of the northeastern lake shore in dugout canoes, hunting and fishing more intensively than pastoral Dassanetch, while the women, children, and older men of their families remained at the home settlement. A similar foraging strategy was pursued by other recently impoverished persons from the pastoral settlement at Ileret (Fig. 1), who created some camps analyzed in this article. In 1974, much of northeastern Lake Turkana was incorporated into Kenya’s Sibiloi National Park, and fishing and hunting were banned along some 60 km of shore formerly used by *gal dies*. Our 1970s survey was made just before creation of the park.

Site 105 of this study differed from the rest, being a large temporary camp set up by pastoralist families from the Ileret settlement. Its layout was typical of pastoral Dassanetch defensive settlements, and its bone assemblage included many domestic animal remains, discussed in detail elsewhere (Gifford-Gonzalez 1989) and not recapitulated here. However, fish and lake reptile bones in the Site 105 assemblage indicate that even pastoral Dassanetch used such wild foods (Table 1).

The people who made these foraging camps were thus not “hunter-gatherers,” but members of a food-producing society who, due either to long-standing historic factors (*gal dies*) or to more recent misfortune, were obliged to forage for wild animals along the lake margin. As such, they may have been less efficient in acquiring the wild animal and plant resources than would have been groups descended from
generations of people subsisting primarily by foraging.

One camp reported here (AS1) was created on the western side of the lake near the settlement of Kalakol by men of the Turkana ethnic group. Most Turkana are by preference pastoralists, but some live almost exclusively by fishing, producing for both subsistence and commercial markets. At the time of our research, Turkana people had more contact with international aid and development organizations than did the Dassanetch. The AS1 fishers observed and interviewed by Stewart were in fact members of a fishing cooperative which marketed dried fish outside the local community. They were less mobile than gal dies, lived in a village near their fishing camp and used commercially manufactured nets to catch fish.

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### TABLE 1

Site Sample Characteristics; a Similar Table Appeared in Stewart and Gifford-Gonzalez (1994), But Subsequent Changes in Fish Systematics Are Noted Here

<table>
<thead>
<tr>
<th>Site No</th>
<th>Distance to shore (meters)</th>
<th>Fish MNI</th>
<th>Other MNI</th>
<th>Occupation type and duration</th>
<th>Area (m²)</th>
<th>Fish NISP/m²</th>
<th>Other NISP/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>330</td>
<td>2L</td>
<td>58REP, 9MAM</td>
<td>repeat/unknown</td>
<td>875</td>
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<td>N/A</td>
</tr>
<tr>
<td>02</td>
<td>1</td>
<td>1C, 1L</td>
<td>1REP, 1MAM, 1AVE</td>
<td>repeat/5 days</td>
<td>3825</td>
<td>N/A</td>
<td>0.04</td>
</tr>
<tr>
<td>03</td>
<td>100</td>
<td>1S, 1Ci</td>
<td>2REP</td>
<td>single/unknown</td>
<td>29</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>04</td>
<td>1</td>
<td>2C, 20L, 1S, 1Ci</td>
<td>11REP, 4MAM</td>
<td>repeat/unknown</td>
<td>7000</td>
<td>0.08</td>
<td>0.10</td>
</tr>
<tr>
<td>05</td>
<td>1</td>
<td>5C, 26L, 1S</td>
<td>54REP, 6MAM</td>
<td>repeat/unknown</td>
<td>5000</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>06</td>
<td>300</td>
<td>1B, 33C, 11L, 10Ci</td>
<td>7REP, 8MAM</td>
<td>single/35 days</td>
<td>1800</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>07</td>
<td>1</td>
<td>2C, 6L</td>
<td>24REP</td>
<td>repeat/unknown</td>
<td>3300</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>08</td>
<td>400*</td>
<td>1S</td>
<td>1REP, 2MAM</td>
<td>unknown</td>
<td>784</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>09</td>
<td>1</td>
<td>1L</td>
<td>2REP, 1MAM</td>
<td>repeat/unknown</td>
<td>500</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>3B, 3C, 10L</td>
<td>8REP, 2MAM</td>
<td>single/7, 2 days</td>
<td>1575</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>1L</td>
<td>2MAM</td>
<td>single/0.5 day</td>
<td>6</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>15</td>
<td>70*</td>
<td>4C</td>
<td>6REP</td>
<td>unknown</td>
<td>7</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>18</td>
<td>1200*</td>
<td>1C</td>
<td>8REP, 2MAM</td>
<td>unknown</td>
<td>300</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>20</td>
<td>400</td>
<td>13C/B, 2L, 4Ci</td>
<td>4REP, 1MAM, 1AVE</td>
<td>single/4 days</td>
<td>391</td>
<td>0.90</td>
<td>1.50</td>
</tr>
</tbody>
</table>

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Note. *Sites formed before 1970; B, *Bagrus*; C, *Clarias*; Ci, *Cichlid*; L, *Lates*; Ot, other; S, *Synodontis*; CYP, Cypriniformes; CHR, Characiformes; SIL, Siluriformes; PER, Perciformes; TET, Tetraodontiformes; AVE, Aves; MAM, mammal; REP, reptile; N/A, not applicable, no NISP available. For repeated-occupation sites, duration of most recent occupation is given.

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### Gear and Animal Acquisition

The standard Dassanetch fishing and reptile hunting tool kit was a spear and less commonly a detachable-head harpoon with either a broad, flat spear blade or a metal hook as the armature. No nets were used. One was given to the men who created Sites 10 and 20 by photographer Robert Campbell in 1972, and this soon fell into disrepair (R. Campbell, personal communication 1973). Given their poverty, gal dies and other Dassanetch people who foraged along the shore had no access to illegal, expensive, and locally rare firearms. Other gear included kerosene tins, used to carry meat filleted from larger animals and to boil fish and reptiles, knives (often homemade from large nails or archaeologists’ survey stakes), and occasionally a *panga*, or bush knife. Be-
cause there were no trading posts in the region in the 1970s, the latter were rare commodities that even affluent Dassanetch had difficulty obtaining. *Pangas* owned by the foraging groups were gifts from filmmakers and foreign researchers.

Informant interview indicated that habitually used foraging sites would be situated near good inshore fishing grounds, close to sand bars used for basking by crocodiles, and/or within reach of sloughs where terrapins were likely to estivate. To catch fish, men would stand or walk slowly in the shallows of good fishing grounds, searching for surface disturbances that belied presence of a fish, then cast their spears. Gifford-Gonzalez did not closely monitor rates of fishing return, but these appeared highly variable; especially on windy days when the water surface was disturbed, these tactics produced meager results. Robert Campbell (personal communication, 1973) reported to Gifford-Gonzalez that a group he traveled with and filmed for a week caught no fish for three consecutive windy days and lacked any supplemental food. However, Sites 10 and 20 reflect a much richer take per day (see below).

To take crocodiles, soft-shell turtles, and very large Nile perch and catfish, *gal dies* parties with dugout canoes used another strategy. While some men poled the canoes a few meters offshore, others walked parallel to them on land, attempting to trap crocodiles basking on sandbars and turtles and large fish pursuing prey in the shallows between canoe and shore and dispatching them with spears.

*Gal dies* informants said that hippopotamus were hunted using the same general strategy, an event documented at Site 02 (Figure 1) by photographer Bob Campbell in 1972 (personal communication 1973). A hippo kill was the best possible outcome of a *gal dies* foraging expedition, as its nutritional contribution eclipsed those from all other taxa. Meat and fat would be stripped, dried, and transported to the home settlement. Hippo hunts involved detachable-head harpoons with line-and-palm trunk floats and cooperation of at least three canoes. By informants’ accounts, such kills were made at considerable risk to the hunters. Hippos can make devastating attacks on land and in water, and informants said that harpooned animals could haul canoes into deep water and sound. A successful hunt was in fact an extraordinary occurrence, achieved only through fortuitous encounter with these rare and wide-ranging animals. In all the Dassanetch littoral sites surveyed by Gifford-Gonzalez in a 16-km-long zone, spanning at least 8 years’ accumulation, only four *hippopotamus* individuals were represented (Gifford 1977).

Terrestrial mammal meat was obtained by capturing very young topi, oryx, and Grant’s gazelle, probably by direct pursuit, although informants were reticent on this point, and by scavenging adult victims of lion kills, mainly common zebra, topi, oryx, and Grant’s gazelle. During 1973–1974, lions were killing zebra in preference to other ungulates in the study area (Gifford 1977), making relatively more carcasses of this species available for scavenging. Dassanetch informants stated they would not use carcasses of animals thought to have died of disease. In contrast to Hadza foragers’ aggressive pre-emption of carnivore kills (e.g., O’Connell et al. 1988, 1990), Dassanetch informants stressed they would approach lion kills only after the lion was considered to have eaten its fill, a practice that may have stemmed from their lack of firearms or other means of defending themselves from attack by predators, such as Hadza hunters’ poison-tipped arrows. Lions in the area showed little inclination to flee human beings they encountered on foot. Dassanetch foragers also collected mammal bones from the landscape for making ornaments and tools. These raw materials
often came from animals that had died many months prior to the creation of the sites to which they were transported.

**Fish Processing Practices**

Stewart’s interviews with Turkana and Dassanetch fishers documented standard handling of perciform fish (cf. Stewart and Gifford-Gonzalez 1994). (1) To avoid injury to hands during processing, dorsal spines were cut off and discarded early in butchery. (2) Body was scaled either with a knife or a large perch operculum (gill cover bone). (3) Lateral muscle masses were filleted for boiling. (4) Fish was gutted and intestines reserved for consumption. (5) Fish body was then cut into five segments for cooking: head plus first trunk vertebra (gill arches removed, filaments kept for stewing, balance discarded); vertebral segment (dorsal fin to anterior to anal fin); vertebral segment (anal fin to anterior caudal peduncle); vertebral segment (anterior to posterior caudal peduncle); tail.

Turkana informants noted that all body sections except the head were usually boiled until the meat fell from the bones, and the resulting stew eaten with boiled maize meal, a commodity to which they, but not the Dassanetch, had trading access. If maize meal were not available, all the fish sections would have been roasted. Large fish heads were split lengthwise on the underside by cutting anterior to the cleithra, spread apart, and placed to roast directly on the fire. In consuming roasted larger fish heads, braincases were broken in half and neural tissue extracted and eaten. Turkana fishers roasted tilapia and other smaller fish whole for immediate consumption.

**RESEARCH METHODS**

**Field Documentation**

Sixteen camps were documented by Gifford-Gonzalez in 1973 in a total-cover-
Gonzalez's sample included sites that, from the condition of the mammal bones, were 5 to 7 years old when surveyed (Gifford 1984). Sites with such weathered bones usually lay far from the shoreline in 1973 but near abandoned strand lines cut by the lake high stand documented in aerial photographs taken in 1970. At the time of their creation these sites may thus have been much closer to the lake than when documented in 1973 and are so noted in Table 1.

Areal densities of bones were calculated as NISP/Camp Area (square meters), but the means of estimating site area should be described. Those surveying ethnographic sites face the problem of defining the outer limits of a site, since human activities may disperse rare items far away from the densest concentrations of materials. Gifford-Gonzalez stopped mapping items either where the density of bones approached that of the natural “background” of bones on adjacent land surfaces (the practice for older sites) or, in the case of more recently occupied sites, where she encountered the last bone elements that could clearly be related to elements in denser areas of the site. These bones were distinguished by virtue their freshness, presence of human modifications, or anatomical associations with carcasses of animals documented in the denser concentrations.

One of Gifford-Gonzalez’s mapped occurrences, Site 20, was buried in fluvial sediments in 1974 and the core area later excavated the same year (Gifford and Behrensmeyer 1977). Recovered bones were reanalyzed by Stewart (Stewart and Gifford-Gonzalez 1994) and Rybczynski (Rybczynski et al. 1996).

To obtain samples accumulated without human agency, Stewart (1991) undertook quadrant and transect surveys of modern and fossil fish bones on littoral land surfaces east and west of the lake.

The NISP and MNI were reckoned for fish and reptile species by methods described in Klein and Cruz-Uribe (1984). For fish from FC1, FC2, AS1, and Site 20, proportions of cranial, axial, and epaxial elements were calculated. Cranial elements are defined as those anterior to the vertebral column, including cleithral bones and mandibular elements, axial elements are defined as vertebral elements only, and epaxial as fin elements. Gifford-Gonzalez did not closely enumerate epaxial elements in her survey, and these have been excluded from most counts in this article, though enumerated for the excavated Site 20 sample.

Stewart recorded evidence for burning and cutmarks on fish bones from her three studied sites. Gifford-Gonzalez recorded burning, breaks, and hackmarks on fish and reptile bones from Site 10 and 20, but did not make the same detailed analysis of other sites’ bones as did Stewart and Rybczynski for AS1, FC1, and Site 20.

In 1992–1993, Rybczynski reanalyzed the 2960-specimen assemblage excavated from the Site 20, and she documented element, portion preserved, side, taxon, size category within the taxon, and modifications. Following Stewart’s and Gifford-Gonzalez’s earlier practice, elements were grouped into cranial, axial, and epaxial for fish and into cranial, axial, and appendicular for reptiles. For the crocodiles and turtles, cranial elements are defined as all bones anterior to the first cervical vertebra, axial elements include vertebrae and ribs, and appendicular bones include pectoral and pelvic girdle elements plus limb bones. Because of their functional association with spinal elements during handling by humans, chelonian carapace and plastron elements and crocodilian dermal scutes were included in the axial category.

Rybczynski calculated NISP and MNI for Site 20 bones as had Gifford-Gonzalez and Stewart, but she made separate MNI estimates for each size category within a taxon. Her aim was to produce estimates
most comparable to Gifford’s original, animal-by-animal field tally of individuals collected by the camp inhabitants (Gifford and Behrensmeyer 1977). Size-grouped MNI estimates normally produce higher total MNI numbers than do pooled elements of a taxon (Grayson 1984). Rybczynski determined the Minimum Number of Elements (MNE) by including only elements 50% or more complete. This differed from Gifford-Gonzalez’s approach to MNE, which involved noting every recognizable portion of an element and then excluding complementary portions that might have derived from the same element (e.g., proximal versus distal humeral ends of similar size from a given taxon) from the final MNE count.

Following Stewart’s earlier methods with Lake Turkana fish bone assemblages (cf. Stewart and Gifford-Gonzalez 1994), Rybczynski noted three types of bone modification to fish and reptile elements from Site 20: burning, cut, and slice marks. As defined here, cut marks do not penetrate deeply into the bone, whereas slice marks shear deeply into or entirely through an element.

Taxonomic diversity was calculated, using Simpson’s Index (Simpson 1949; Peet 1974): \( D = 1 - \frac{E(\pi^2)}{\pi^2} \), where \( \pi \) = the relative abundance of species, measured on a scale of 0 to 1, based on the calculated MNI statistics.

**CASE STUDIES IN SITE AND ASSEMBLAGE STRUCTURE**

The Appendix details the spatial organization, associated artifacts and features, observed prey processing techniques, and resulting characteristics of bone assemblages at seven of the best-documented camps in our study sample. This comprises five Dassanetch aquatic foraging camps from the Gifford-Gonzalez survey, plus one Dassanetch and one Turkana camp from Stewart’s research. This section documents the range of physical outcomes of variable foraging behaviors of one cultural group (plus one Turkana site). Dassanetch sites include a very short-term “snack site,” single and repeated occupation camps, and a large animal butchery locale. Data are presented on a case-by-case basis, detailing when known the progressive development of site structure.

**Discussion**

This section reviews patterns of site structure, assemblage element frequencies, and bone modification apparent in the aquatic foraging camps detailed in the Appendix and others in the study sample. We attempt to link observed patterning in the sample data to the human choices that created them and to factors underlying those choices.

**Site location and animal resource exploitation.** Locations of the aquatic foraging camps are clearly related to food resources exploited, with priority to the most predictable rather than the potentially highest yielding resources. Around 67% of camps lay within 100 m of the shoreline and another 17% of older surveyed sites were probably within the same distance of the lake when created (Table 1, Fig. 1), totaling 84% of the sites. Only 42% of the camps lay near sedge stands, yet all but one repeatedly occupied site lay near them, which agrees with informant interviews on camp site preferences. Fish breed, go through their early stages of growth, and hunt in the shelter of Lake Turkana’s restricted patches of inshore vegetation (Hopson 1982). Young Nile perch (<25 cm length) prefer vegetated areas that afford them protection from predators, and larger perch, themselves ambush predators, lurk in areas of limited visibility, using vegetation or rocky overhangs for concealment (Hopson 1982:1294). The littoral between Koobi Fora and Allia Bay has only a few rock outcrops, and stands of aquatic vegetation are thus especially important predation
zones for larger *Lates*. Concentrations of fish species in sedge stands would therefore be a rich and predictable source of food. Site 20 testifies to exploitation of another locally concentrated taxon, estivating terrapins in a slough.

At camps observed while occupied, no plant foods were gathered and eaten. The only evidence for plant processing came from unidentified nut shells at Site 03 and sedge tuber debris at Site 06. Pastoral Dassanetch informants described sedge tubers as famine food, a source of carbohydrates when other foods failed in drought years (Gifford 1977). Sedge tubers can be roasted in coals, peeled and eaten or roasted, ground into meal, mixed with water, and boiled. The latter process requires grinding equipment normally quarried, shaped, and used by Dassanetch women. No grindstones were observed at any of the all-male camps but were encountered at Site 06, where a woman did live. Sedge tubers could have been consumed simply by roasting and peeling, but no such gathering debris was observed at Sites 10 and 20, despite the former’s proximity to a sedge stand. Thus, the dominance of faunal remains at the sites appears to reflect their dietary dominance rather than the outcome of preservational bias.

Among sites created or reoccupied in 1973, where the effects of taphonomic deletion of bone would have been comparable, considerable variation exists in proportions of fish, reptile, and mammal remains. Fish comprised 40% or more of the total numbers of individuals at the majority of sites in the sample, but proportions ranged from 2.8% at Site 01 to 100% at FC2. Moreover, fish MNI and NISP markedly dominated those of reptiles only at the three special-purpose fish production camps (AS1, FC1, FC2).

Chelonians and crocodiles accounted for MNI equal to or greater than that of fish at half the 18 Dassanetch aquatic foraging camps. Reptile MNI outnumber fish MNI by ≥2:1 in 46% of the 1973 sample (Table 1). Reptiles’ use of specific littoral locales according to set daily or seasonal schedules, from crocodiles’ daily basking on sandbars to terrapins’ dry-season estimation in sloughs, make them spatially and temporally predictable resources for human foragers. Some forager camps were located primarily to exploit these species, as was the case at Site 20, and older sites may have been situated with similar motivations.

Mammal remains were much rarer at these camps, but this must be viewed in light of both Dassanetch scavenging methods and environmentally conditioned potential yields. In contrast to carcass-scavenging opportunities in the higher-biomass Serengeti (cf. Blumenschine 1988), the East Turkana littoral showed situationally high availabilities of fresh flesh and neural tissue in lion-killed carcasses. During seven months in 1973–1974, Gifford-Gonzalez (1984) monitored about 45 natural wild ungulate deaths in the site survey area discussed in this article. With these carcasses, the “window” of scavenging opportunity was more often closed by swift natural mummification than by consumption by nonhuman scavengers.

In her taphonomic analysis of ungulate carcasses in the area, Gifford-Gonzalez found traces of human scavenging on two lion-killed zebras, which contributed meat and body segments to Sites 10 and 20, respectively (Appendix). In both cases, flesh had also been stripped from some body segments for transport in a container, and the meat yields were thus greater than would be implied by the zebra bones carried to the sites. Fully fleshed limbs that would remunerate transport were rare among the scavengeable animals, as lions had usually consumed the upper hind- and forequarters. Container transport permitted efficient collection of meat scraps from partly con-
sumed body segments. The effects of the 6-year drought also militated against long bone transport in 1973–1974, in that wild mammals’ marrow reserves would have been much reduced.

Three sites occupied in 1973 (Sites 06, 10, 20, Appendix) did include body segments of adult zebras or larger antelopes. At Site 10, one zebra limb bone was brought in and broken open; the cranium was also transported and the brain extracted. At Site 20, a zebra hind limb was carried back for defleshing, but none of the long bones were fractured. As noted above, the Site 06 foraging camp contained both fragments of adult antelopes and bones from two very young ungulates, probably direct prey of the site occupants (Gifford-Gonzalez 1984, 1989).

The mummified zebra at Site 10 illustrates the complexities of trying to discern hominid bone accumulations from those building up on the same land surfaces by natural processes. Evidence for its lack of behavioral association with the rest of the assemblage as a food animal might include lack of human modifications to its bones (in contrast to the remains of the scavenged zebra bones at Site 10). However, given the low rates of occurrence of hammerstone impact and cut mark “signatures” on bones, it is moot if these elements could be distinguished as nonfood remains. Long bones of this zebra remained unbroken until well-weathered and broken by trampling several years after death (Gifford-Gonzalez 1984). Refits and analysis of fresh versus weathered break surfaces might suggest that the assemblage was such a palimpsest.

Meat and neural tissue from scavenged mammals would provide a major nutritional input to the foragers who made these camps. However, these deaths were predictable in neither time nor space, and they apparently had little influence on site location. During the span monitored by Gifford-Gonzalez, lions in the Koobi Fora–Allia Bay littoral were habitually killing prey in at least two “kill arena” locations, but foraging camps were situated neither near these locales nor near sites of the known scavenging events, which were up to 3 km from camp.

In sum, taxonomic composition of aquatic foraging camp assemblages reflect a restricted and opportunistic sampling of species encountered in the aquatic and terrestrial portions of the littoral zone. Sites were often situated to maximize chances of encounter with fish and reptile food species. Scavenging opportunities were intermittent and apparently did not dictate choices in site location. Differences in taxonomic proportions among assemblages thus reflect the situationally variable feeding opportunities and strategies employed at individual foraging camps.

One may ask which aquatic or terrestrial resources among those obtained would offer the highest nutritional returns and which therefore might be preferentially sought out in foraging or considered when situating camps. Figure 2 presents values for fat, protein, and kilocalories per 100 g of flesh for horse, species of catfish and perch, European freshwater turtle, green sea turtle, and American alligator. These taxa are proxies for African catfish, perch, terrapin, crocodile, and zebra, for which food composition values could not be obtained. The figure shows that fish do not form a unitary category in terms of nutritional yields. Catfish offer substantially more fat than do perch species and should therefore be higher-ranked prey in circumstances where both taxa are available to foragers with a fat-poor diet, as were the persons who created the Lake Turkana sites. Crocodilians offer relatively high fat returns but more impressively, much as many calories per unit of flesh than do fish, chelonians, or even the horse. It should be noted that the relatively low fat content of reptile flesh reflects the focus of food composition anal-
yses of muscle rather than viscera, where both chelonians and crocodilians store lipids. Horse flesh, while offering a comparable level of fat to that of catfish and crocodilians, is not a significantly higher source of protein than former and is much less so than the latter. These data suggest that actualistic research on relationships between key nutrient yields versus taxonomic abundances of aquatic vertebrates, and the relation of both to site location, is merited. However, our dataset lacks the requisite detail on abundances of aquatic species to explore this topic.

As noted at the beginning of this article, the lifestyle documented here is not truly “hunter-gatherer,” although the sites were created by foraging for wild species. The carbohydrate-poor intake of male *gal dies* foragers must be seen in light of the farm produce-heavy diets of *gal dies* women and children at the home settlement. The seemingly hit-or-miss fishing methods observed are probably best viewed not simply as far short of optimal offtake but as serving two other, simultaneous purposes. First, the fishing expeditions kept one age/sex group of consumers (adult males) away from the carbohydrate stores of the *gal dies* women, children, and the very old. Second, fish and reptiles taken sustained the parties while they searched for richer resources: large reptiles, well-fleshed mammals killed by lions, and, optimally, hippopotamus. Mass drying of fish seen at FC1 and FC2 could be seen as a governmentally tolerated attempt on the part of the *gal dies* to cope with the new National Park’s anti-hunting policies by providing some animal protein for their home settlement.

**Site densities, areas, and site structure.** The 1973 Koobi Fora–Allia Bay survey revealed a relatively dense landscape sample of foraging camps on about 20 km$^2$ of littoral, averaging one site every kilometer along the shore (Fig. 1, Table 1). Known lengths of camp occupation varied from the snack stops of a few hours (e.g., Site 03) through short term (1–7 days, Sites 10 and 20) to

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**FIG. 2.** Fat (gm/100 gm), protein (gm/100 gm), and kilocalories per 100 gm available from catfish species (Scherz and Senser 1989; USDA 1998), freshwater perch species (Scherz and Senser 1989; USDA 1998), freshwater turtle (Scherz and Senser 1989), green turtle (Pennington and Church 1985), alligator (Pennington and Church 1985), and horse (Pennington and Church 1985), serving as proxies for related African taxa, for which no food composition data are available.
longer term (1–8 weeks, Sites 06, 105). Approximately half the camps were repeatedly occupied by different successive foraging groups at named locales known to all fishers.

Most repeatedly occupied camps (Sites 02, 04, 05, and FC1) had constructed facilities. Primarily these were low, semicircular windbreaks of local stone used to shelter from the prevailing offshore winds while sleeping or to protect hearths from the same winds. One camp had a pole and sedge thatched shelter. At other locales (Sites 01, 06), inhabitants took advantage of natural vegetation for sheltered sleeping and cooking areas. Some single-occupation sites, such as the original occupation of Site 10 and Site 20, had no shelter other than modest variations in surface relief.

In sites observed in use, large fish, soft-shell turtles, and crocodiles tended to be butchered away from the main loci of cooking and daily activity. Spatial segregation of large fish and reptile processing parallels previously recorded cases of noisome or dangerous work being carried out in areas peripheral to the central residential space of camps (e.g., Yellen 1977; Binford 1978; O’Connell 1987).

Given the cautions expressed in Research Methods, estimated areas of the foraging camps varied tremendously, from about 6 m\(^2\) (Site 06) to 8400 m\(^2\) (Site 105, Table 1). Repeatedly occupied foraging camps tended to have greater areas than short-term and single occupation camps, probably as the result of the gradual build-up of a palimpsest of butchery areas within the orbit of repeatedly used hearths and windbreaks. Exceptions are Site 09, a very small repeated-occupation site with an area falling among the single-occupation sites, and Site 06, a single-occupation site falling among the larger, repeatedly occupied sites (Table 1). Site 09 was occupied at least twice, the second occupation being a short “snack stop” by canoeists on their way south to Site 04 in the autumn of 1973. Duration of the earlier occupation is unknown; in any case, the cumulative scatter of bones at the site was relatively small. Much of the areal extent of Site 06 resulted from use of far-flung shrubs as fish-drying racks. Thus, variation in site size can be seen as a product of site function in relation to natural features that constrained or conditioned certain activities.

Such functional relationships are thrown in sharper relief by Site 105, the pastoral camp, which had the largest area of all sites in this sample, even without including two related bone scatters under shade trees outside the settlement’s fences (Table 1). This camp was very differently organized than were the foraging camps, its size inflated both by the number of inhabitants, with 33 households in residence, and by livestock, whose 29 pens make up about 70% of the site’s area. The pens also constrained and structured daily activities at the site, and the distribution of wild and domestic animal bones reflects the influence of site structure on preliminary carcass subdivision, culinary processing, and refuse disposal (Gifford-Gonzalez 1989).

The highest NISP/m\(^2\) ratios for these sites far exceed those of the natural land surface assemblages surveyed (Table 1). Such densities appear to be distinctive of localized human processing activities. However, the lowest areal density ratios for camps in the sample overlap with those of natural land surfaces (Table 1). Our combined dataset thus contradicts Stewart’s earlier (1991) assertion that areal frequencies of bones by themselves can distinguish hominid from natural accumulations. Nonetheless, at more areally extensive sites such as Site 04, smaller clusters of bones (large animal butchery locales and hearth drop and toss zones) are in fact very high density. Thus, a functionally oriented exploration of bone clusters within such large spatial distributions...
may prove more profitable in evaluating hominid agency than simply calculating a single bone element density statistic for the entire site area.

Functional variations in fish processing and assemblage formation. The sites in our sample of aquatic foraging camps at Lake Turkana showed great diversity in size and internal organization, but two functional types were discerned: (1) short-term to long-term base camps, where the main purpose of activities was to support the daily subsistence of the foraging party, and (2) fish production camps, where the main purpose of activities was to obtain and preserve fish in surplus to the foraging party’s daily needs for transport to other locales, augmented by meals during this work. The goals of fish-processing activities influenced site structure and fish element representation patterns of each camp type. Some sites in our sample, such as Site 06, may comprise mixtures of these activities. The Turkana site, AS1, was obviously a production camp, where local fishers processed fish as a commodity to be sold or exchanged in articulation with a modern commercial system. However, preservation en masse does not require a modern commercial system (cf. Butler 1993; Hayden 1994), and we may expect that such assemblages were regularly created in later prehistory, where storage was a common practice. At FC1 and FC2 (not reported here), gal dies foragers acquired and preserved fish above that of their daily requirements to transport to their home settlement.

Fish-production camps in our sample, though repeatedly occupied, lacked the constructed facilities (stone windbreaks, huts, sun shades) and the spatially segregated rest and artifact manufacture zones of base camps. Reptiles and mammals, major assemblage components in most base camps, were absent from the most specialized site, AS1, and in low proportions at FC1. Fish-production camps were also distinguished from base camps by bone element frequencies. Whether short or long term, base camps are characterized by processing, consumption, and discard of fish bones on-site or in the immediate vicinity. Body segmentation in butchery and destruction during culinary processing caused shifts away from element representation in the typical perciform skeleton. Figure 3 shows cranial-to-axial proportions of perciforms in our assemblages (see also Table 2). At two short-term base camps (Sites 10 and 20), relatively more perciform vertebral elements in proportion to cranial elements survived. Fish production camps FC1 and AS1 display much lower frequencies of perciform vertebrae, the result of transport away of backbones off-site in dried fish bodies. Site 06, with at least one fish-drying locus, resembles AS1 almost exactly, although we cannot dismiss the possibility of equifinality of effect due to the sampling problems discussed earlier.

Figure 4 shows a more variable pattern of element representation in the siluriform component from different foraging camps. Siluriform vertebral elements were rare to totally absent at fish-production camps FC1 and AS1, and they are nearly absent from Site 06, where, based on the same evidence outlined for perciform elements, transport away from the site in dried axial body segments is a possibility. The natural fragility of catfish vertebrae combines with human culinary processing (specifically, roasting of bones in split axial segments) to render catfish vertebrae more fragile. However, among the base camps, differences in handling produced substantial variation in catfish vertebrae frequencies. In comparison to other camps, Site 20 has unusually high proportions of vertebral to cranial elements, while Site 10, produced by the same persons during the same season, had no vertebrae in evidence and resem-
bles many of the other sites in the area (Figure 4, Table 2). Documentation of processing activities at the two sites is not sufficiently detailed to explain this difference, which might result from deletion of cranial elements or vertebral elements by off-site discard, destructive processing, or transport to the next site occupied. Variations in fish body segment representation at foraging camps are thus clearly linked to differences in handling, most specifically, whether selective preservation and transport of body segments took place. Patterns seen in our sample are very similar to those Butler (1993) describes for element frequencies of sockeye.
salmon (*Oncorhynchus nerka*, a perciform) at human processing sites versus a natural point-bar accumulation. The point bar accumulation displayed slightly increased proportions of axial to cranial, relative to the sockeye skeleton. Human processing sites, depending upon whether they were locales at which crania were processed for oil or those to which segmented axial skeletons were transported, were dominated by either axial or cranial elements. In his ethnoarchaeological research with market-oriented South Asian fishers, Belcher (1994) notes that fish to be dried were

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**Note.** Average skeleton for each taxonomic group: Lake Turkana ethnoarchaeological Sites 06, 10, 20, FC1, AS1; Stewart’s (1991) East Lake Turkana modern and fossil bones from littoral land surface samples; Olduvai fossil fish assemblages from FLKNN-Level 3; FLK-Zinjanthropus level, and BK.
handled differently than were those to be sold fresh (equivalent to fish consumed immediately at our sites). As with our cases, vertebral columns stayed in the dried bodies and left processing areas. Belcher (1994) also notes size-dependent differences in butchery of Osteichthyes, which includes perciform fish. In
Belcher’s study, he reports that fish >25 cm were processed in similar ways to larger fish handled by Turkana and Dassanetch fishers: gills, entrails, fins, and tails were removed early in butchery and discarded. In fish >1-m long, the head was detached and both it and the body were marketed. In Belcher’s socially stratified context, culinary processing varied according to the access of different socioeconomic classes to higher or lower ranked body segments.

Distinguishing human from natural fish bone accumulations. A substantial literature exists on distinguishing effects of hominids on mammal bones from those of nonhuman agents (cf. Lyman 1994), but little has thus far been published on similar distinctions for fish bones. We (Stewart 1991; Stewart and Gifford-Gonzalez 1994) have previously specified three distinctions between human and naturally formed fish bone assemblages: (1) when technology limits foragers’ access to the inshore zone, resulting assemblages are of limited taxonomic diversity and size range, compared to natural littoral accumulations; (2) hominid processing marks bones in ways preservable in archaeological assemblages; and (3) hominid processing creates skeletal element proportions differing from those of natural littoral assemblages. We discuss each in turn, including related research and the possibility of discerning such modifications in assemblages handled by premodern hominids.

The living fish fauna in modern Lake Turkana has a taxonomic diversity index of .83 (Stewart 1991). Diversity indices for natural fish bone assemblages in Stewart’s East and West Lake Turkana littoral transects were .76 and .78. Taxonomic diversity indices calculated for Sites 06, 10, 20, FC1, and AS1 (where appropriately detailed numeric data existed) were .43–.62, reflecting the fishers’ inshore fishing strategy. Premodern hominids would be expected to have even more limited abilities to prey on aquatic species. Prey size selectivity also distinguishes human assemblages. As reported by Stewart (1991:18–19) for FC1, fishers selected medium-sized (30–85 cm) cichlids and catfish; smaller size classes of the same species occurred in much lower proportions than in natural land surface assemblages. We would expect similar selectivity among premodern hominids.

Modifications to fish bones inflicted during processing clearly distinguish human-generated assemblages. Any hominid with a cutting tool would encounter similar anatomical challenges when handling fish as a food; cutmarks may be expected to occur in similar locations. Stewart’s observations suggest that crania of larger (>30 cm total length) fish, especially braincases, should be checked for cutmarks. However, some body segmentation observed in our study was in preparation for cooking and might not be expected in sites antedating the use of fire. Moreover, cuts occur in very low frequencies in assemblages produced by anatomically modern humans. Cutmarks inflicted while segmenting the body and extracting neural tissue from the braincase are predictable in location, but their low rate of occurrence in our samples (Site 20: <1%; FC1: 8.1%; AS1: 4%) suggests that an extensive sample must be examined when assessing hominid agency. Low frequencies of cuts and slices are not restricted to the Lake Turkana sites. Of 2722 identifiable fish elements in the fauna from the late prehistoric McIntosh Site (25BW15) in Nebraska, reported by Koch (1995), none displayed cutmarks.

Burning due to roasting is distinctive of human processing and was present on as much as 20% of elements from some sites; in our sample, larger fish heads and smaller whole fishes were prepared in this manner. Koch (1995) notes that 13% of all charred bone elements at the McIntosh
Site was from black bullheads (*Ictalurus melas*), a catfish taxon, the fish averaging no more than 0.5 kg, a size likely to be roasted whole by Lake Turkana fishers. Burning is likely to render fish bone more fragile in the face of destructive processes, as it does mammal bone (Stiner et al. 1995; Nicholson 1993; Taylor et al. 1995).

Fish braincase fragmentation is especially distinctive of hominid agency in the Lake Turkana camps. An average of 50% of braincases in base camp assemblages were fractured, while braincases in natural land surface assemblages from the same littoral zones displayed less than 2% fragmentation (Stewart 1991:20). Because braincase breakage requires only an unmodified stone or piece of wood, it is within the abilities of any hominid handling a fish, though Stewart's observations indicate that isolation of the braincase is facilitated by cutting tools.

Skeletal element frequencies in all human-generated fish assemblages differed from those of natural land surface assemblages. Figure 3 shows the proportional element representation for cranial and axial elements in an average perciform body (e.g., *Lates, Oreochromis*) and in the land surface assemblages surveyed by Stewart (1991) in comparison to perciform cranial to axial proportions at foraging camps (see also Table 2). Proportions of perciform cranial-to-axial elements in land surface assemblages differ only slightly from those of the perciform body, suggesting that natural taphonomic effects in and of themselves do not substantially skew these proportions. By contrast, human-processed assemblages display strong deviations from the land surface pattern, but variably from site to site, as discussed above.

Among catfish, greater divergences emerge between proportions of vertebrae in the body and those in recent bones on land surfaces (Fig. 4, Table 2), reflecting a greater natural vulnerability to attrition of catfish vertebrae (see Appendix, Site 10). Human-processed fish assemblages present an even starker contrast with the original cranial:axial proportions (Fig. 4, Table 2), reflecting combined effects of inherent fragility and human processing on vertebrae.

**Comparisons with fossil fish bone assemblages.** Stewart (1991, 1994) has examined fossil fish remains at several Olduvai Gorge sites for evidence of human modification, comparing them to the naturally deposited land surface assemblages of fish bones at Lake Turkana. Three Olduvai site fish assemblages, FLKNN Level 3, FLK-Zinj, and BK, differed from naturally deposited assemblages in several characteristics. FLKNN-3 and FLK-Zinj are interpreted as lake shore assemblages, while BK is a channel site. It was suggested that predators, possibly hominids, were responsible for the assemblages.

Further examination of the Olduvai fish assemblage data was done in light of the data on modern human fish processing presented here. Fish elements were not abundant at the FLK and BK sites, though more numerous at FLKNN-3. Perciform element numbers are very low compared with numbers of siluriforms (Table 3); BK had only five cichlid elements. Due to such low numbers of perciform bones, comparisons could only be made only with the siluriform component.

Results in terms of body segment representation and bone surface modifications are equivocal, highlighting the difficulties in discerning hominid agency in the absence of fire-aided culinary processing, of large-scale acquisition and processing, or obvious features and facilities. A brief review of the assemblages delineates these problems.

Percentages of siluriform cranial to axial elements at all three Olduvai sites are very similar, with roughly 90% cranial to 10% axial across the three assemblages, despite differences in their respective sedimentary contexts (Fig. 5, Table 2). These
proportions depart from those of the typical siluriform skeleton (Fig. 5), as was the case for all human and natural land surface assemblages at Lake Turkana. This probably reflects in part the inherent fragility of siluriform axial elements discussed previously. The loss of axial elements is not so extreme as at several of the ethnoarchaeological sites at which fish processing for transport occurred (AS1, Site 06) or where the cause is unknown (Site 10), but the BK1 assemblage approaches FC1 in proportions (Fig. 4). Only Site 20 has cranial-to-axial proportions approaching those of the Olduvai sites. However, given that the Olduvai assemblages have undergone diagenetic effects not affecting our ethnoarchaeological samples, the most apt comparison may be the body segment proportions among fossil bones encountered on the Lake Turkana littoral land surfaces in Stewart’s transects (Fig. 5, Table 2). Proportions of siluriform cranial:axial elements in the Lake Turkana fossil land surface assemblage are remarkably similar to those in the three Olduvai sites (Table 2, Fig. 5) and display such internal homogeneity. This may bespeak the overriding influence of regional taphonomic processes on structuring bone assemblages of similar taxa.

Interpreting the causes of these patterns is moot for a variety of reasons. The hominids who might have handled the fish bones at the Olduvai sites lacked fire, thus eliminating a major cause of *in situ* destruction of siluriform postcranial elements, and they may be assumed not to have engaged in intensive surplus production of dried fish. On the other hand, transport of fish axial segments—the more rewarding and less potentially hazardous sections of catfish bodies—away from a butchery locale would not have beyond capabilities of hominids accepted to have transported mammal body segments. Nothing in the assemblages themselves definitively argues for or against hominid versus purely taphonomic (possibly postdepositional) influence on body segment frequencies.

Unfortunately, bone surface modifications are not informative in this regard, because of their low incidence of occurrence and ambiguous nature. Surface modifications were observed by Stewart on only two fossil elements in the three Olduvai assemblages, a frontal bone and a dermethmoid bone, both from the BK site. The modifications could be interpreted as either toothmarks, presumably from a carnivore, or cutmarks made by hominids (Stewart 1994). The low rate of modification does not in and of itself rule out hominid handling, given the low rates of incidence of cutmarks on the modern fish bone assemblages analyzed by Stewart (see above).

**Patterned effects of reptile processing.** Our observations on modification to reptile elements require evaluation in light of more

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*Note.* Data from Stewart (1994).
samples; however, one other case of turtle processing accords with ours in some aspects. Charring of turtle shells appears to be a hallmark of modern human handling. Koch (1995) reports high rates of charring on terrapin shell elements in the McIn- tosh Site fauna: 50% of all burned vertebrate elements derived from three species of freshwater turtle (NISP = 191; MNI = 6), which comprised only 3% of assemblage MNI. Bison, representing about 4% of MNI of the same fauna (NISP = 593;

FIG. 5. Siluriform cranial and axial proportions (epaxial elements excluded for interassemblage comparability): Sites FLKNN-Level 3, FLK-Zinz, BK, and Olduvai Gorge; average siluriform body; and Stewart's (1991) Lake Turkana land-surface-survey modern and fossil bone assemblage data.
MNI = 32), had a charring rate of only 3%. Slices on the carapace and hypoplastron are also likely outcomes of human handling that could predate the use of fire. We believe it unlikely that site-functional variations in processing would systematically affect reptile element frequencies as they do fish. Given their lower abundances, crocodiles are less likely to be subjects of mass processing, and even if subject to preservation and transport, the condition and frequencies of their elements is unlikely to be distinctive. According to their size, crocodiles may be transported gutted but otherwise whole or their meat may be filleted and dried for transport. Defleshing for drying should not differ from defleshing for immediate cooking. Terrapins are cooked whole and are most conveniently transported whole (and alive) to another locale. Thus, in contrast to fish, selective removal of elements with dried reptile meat is unlikely.

CONCLUSION

The Lake Turkana landscape sample of aquatic foraging camps contributes to understanding the location, internal organization, and faunal assemblage characteristics of sites dominated by nonmammalian fauna. Size variation among the sampled sites was more a function of subsistence activities and of physical features of the chosen locale than of numbers of inhabitants, duration of occupation, or amount of bone or other occupational debris produced. Though fish bones numerically dominate such freshwater sites, the role of aquatic reptiles, a more spatially and temporally predictable food resource, should be investigated further. Scant nutritional data indicate reptiles have higher fat yields than perciform fish, but this requires more exploration.

Systematic human handling of fish and reptile bodies from initial butchery through cooking is reflected in bone assemblage characteristics. Element frequencies from different fish body segments proved an indicator not only of human handling but also of differing processing goals. Human processing also leaves distinctive bone modifications. As Lyman (1993) has suggested is the case for deer, cut marks may be rare and ephemeral on fish bones, but understanding the body size ranges and anatomical regions most likely to be handled with cutting edge facilitates the search for such traces. Braincase breakage, like hammerstone impacts to mammal long bones, may be a very common diagnostic hominid signature. Reptile processing merits further research to establish whether apparent regularities in damage, especially among chelonians, are diagnostic of hominid agency.

Data on impacts of human handling only make sense when compared to that from same the taxa in contexts not affected by humans. We recommend that zooarchaeologists analyzing freshwater vertebrate assemblages follow the examples of Butler (1993) and Stewart (1991) and collect taphonomic comparison sets as part of their research designs. Likewise, it is important to undertake longitudinal weathering and other taphonomic investigations of fish and reptile elements in differing environments to parallel those now in the literature for mammals.

Our study has implications as well for the spatial scale of sampling of prehistoric locales. While archaeologists today know the relevance of “empty spaces” to understanding the organization of activities at sites, the areal extents documented in the Lake Turkana ethnographic sample fall outside areas normally opened by excavations. O’Connell (1995) recently stressed this same point, calling for much more extensive lateral excavation of sites. Such hoped-for reform in excavation practices leaves the problem of how to analyze the
many extant archaeological samples that probably sample the denser end of the bone frequency spectrum at much larger sites. Useful comparisons might be made with ethnoarchaeological datasets from the highest areal densities only. However, some site-structural topics, such as analyses of spatially segregated task sequences, may not productively be addressed by such samples. Further work with contemporary sites may elucidate this issue.

APPENDIX: DETAILED SITE DESCRIPTIONS

Site 02: A Repeatedly Occupied Locale with Hippo Butchery Episode

In the early summer of 1972, a gal dies canoe party killed a young hippopotamus in the lake near Site 02, a repeatedly occupied locale (Fig. 1). They hauled its carcass out of the water at the campsite and segmented it to strip and dry its flesh for transport home (Bob Campbell, personal communication 1973, film footage). Work parties handled the body sections from 3 m to 10 m apart, creating discrete, anatomically coherent bone clusters with little “fill” between them. A stone-lined hearth was renovated and used for immediate food consumption, around which built up a layer cluster of hippopotamus forelimb bones and ribs. The site had two preexisting low windbreaks made from gastropod conglomerate sandstone that served as sleeping shelters from the strong offshore winds that blow most of the year. When surveyed by Gifford-Gonzalez a year after the butchery, some fresh fish and reptile bones lay in the spaces between the hippopotamus bones, the result of later occupations (Fig. 6).

Site 03: A Very Short-Term Camp

Site 03 is a very short-term, single-occupation “snack stop,” at which disparate foods were processed and consumed (Figs. 1 and 7). Located on the northeastern bank of a small ephemeral stream that cut through an abandoned 1970 back-beach bar, it was about 100 m from the shore when encountered in October, 1973. Animal remains at the camp were fresh, indicating very recent occupation, probably by a gal dies canoe party who had passed Koobi Fora 2 days before. Bones, a cut wooden staff 1.5 m long, a branch about 1 m length, and shorter lengths of firewood lay around a hearth with three hearthstones used for supporting a cooking container. Nutshells of an indeterminate species lay south and east of the hearth (Fig. 7).

Despite an NISP of only 16, five animal taxa are represented. Fragments of a gazelle-sized mammal rib are probable food remains, as are two vertebrae, four fore- and hindlimb bones, and a scute (dermal bone) from a small crocodile, reflecting transport into the site of at least the reptile’s postcranial skeleton. A cranial fragment of a Synodontis fish was also present in the scatter. Two specimens, a well-dried softshell turtle carapace about 30 cm in diameter and a tilapia operculum, are probably artifacts. Gifford-Gonzalez saw similar carapaces used as food platters by Dassanetch people in other settings. Stewart observed opercula used as fish-scaling tools at AS1; the presence of this single tilapia element in proximity to fish scales (Fig. 7) suggests a similar use here. Though an ephemeral camp, Site 03 bears hallmarks of human use, not only in the presence of artifacts and hearth, but also in admixture of so many species’ remains in such a small assemblage.

Site 10: A Short-Term Base Camp

History

Site 10 was created November 5–11, 1973, by eight impoverished Dassanetch men who, though not from the gal dies settlement in Ethiopia, followed a similar foraging pattern. The men were working
their way south from Ileret to the rich fishing grounds of Allia Bay (Fig. 1). Camp was set up at the lake’s edge on a flat expanse of dry, hard silts covered by closely cropped of spike grass (*Sporobolus spicatus*). No trees grew within a kilometer of the site, but a large stand of sedges (*Cyperus* sp.) lay about 8 m north of the camp’s central area. The camp was set up around a mummified zebra carcass that had been there since September, 1974 (Fig. 8). The stiff body was occasionally used as a chair.

The foraging party carried a kerosene tin, a fish net in poor condition (photographer Bob Campbell’s gift from 1972), a gourd container, one carved wooden headrest/stool per man, three empty food tins, and several spears. One such spear was tipped with a sharpened end of an oryx horn sheath and the other with a largely unmodified iron nail. The men also had one detachable-head harpoon with several wooden shafts, an oryx sheath foreshaft, and a hook-shaped iron head. One *panga*, or large bush knife, and

![FIG. 6. Plan of Site 02, a repeatedly occupied camp with 1972 hippopotamus butchery. Sandstone windbreaks and hearth existed before 1972 butchery event.](image-url)
a smaller, homemade metal knife were also shared among members of the group. Abandonment debris included battered quartz cobbles collected from the landscape and used as hammerstones on mammal and fish bones. The discarded gourd and headrest shown in Fig. 8 were in fact left at Site 10 during a second occupation, when the party moved back north through the area and built the shelter at the camp during their stay. The shelter was burned by National Park personnel about a month after it was built.

Notes on site activities are relatively coarse grained. Sites 10 and 20 were set up at the beginning of Gifford-Gonzalez’s fieldwork, and their makers were wary of persons who might communicate with game wardens, with whom they had already had unfriendly encounters. She therefore opted to stay at the camps for shorter intervals and to ask fewer questions than she might have, had she been more in the confidence of the inhabitants.

While camped at Site 10, the party fished, hunted lake reptiles, scavenged mammal meat, collected oryx horn sheaths and wood for making harpoon foreshafts and shafts, and carried on tool making and food processing at the camp. Over the 7 days the camp was occupied, the men obtained 21 fish. Eight individual Bagrus, netted in deep water by the research vessel Halcyon, were donated by Gifford-Gonzalez. A Nile perch over 1 m long and a Clarias catfish 1.2 m in length were taken with spears, as were several of the smaller fish. Three crocodiles and four terrapins were caught, and portions of at least four ungulates were collected: those of a lion-killed zebra and a large bovid were scavenged for food, and oryx horn sheaths were acquired for tool making. Maize meal donated by Gifford-Gonzalez was consumed for 2 days, but no other vegetable foods were known to have been eaten. The Site 10 assemblage was identified and mapped in place on November 19, 1973,
eight days after the group moved south and set up the Site 20 camp.

Processing Activities and Site Structure

Site 10 underwent substantial areal expansion during a single occupation episode. Functional considerations, especially food processing, influenced the extent and nature of the bone and artifact distribution. It should be reiterated that the shelter with sitting area in Fig. 8 was built during a second, 2-day occupation by the same foraging party as they returned north. Thus, it did not constrain the location of activities during the initial occupation. Since no trees or shrubs grew in the area, shade was not a consideration in situating the cooking and work areas.

During the first 3 days, two hearths were used (lower center of Fig. 8), one with three hearth stones to support the kerosene tin “pot,” the other used to roast fish body segments. Over this span, fish and reptiles were caught; fish cranial and vertebral segments surround the hearths. Broken ribs of a large bovid of unknown provenience lie near the hearths and in a toss zone west of them.

FIG. 8. Plan of Site 10, a short-term base camp.
During the time Sites 10 and 20 were created, Gifford-Gonzalez carried out her on-foot survey of older camps and monitored all new ungulate deaths in the survey area for a longitudinal taphonomic study (cf. Gifford 1977; Gifford-Gonzalez 1984). She was therefore able to ascertain the actual animals from which scavenged zebra elements were taken at both Sites 10 and 20. However, the bovid which contributed these ribs, either an oryx or a topi, was not located in her survey.

A large Nile perch (*Lates niloticus*) was acquired during this time and underwent primary processing about 20 m northwest of the hearths (Fig. 8), close to the stand of sedges. In its spatial segregation from the main zone of food consumption, work, and rest, the *Lates* processing area resembles activity loci noted in ethnoarchaeological studies of larger mammal processing (see Discussion). It was gutted, its epaxial (fin) spines cut off and discarded, its gills and branchiostegel elements detached and discarded, and the body then cut into sections. Its tail and one gill cover unit were taken to the hearth without stones, where it was roasted with the large catfish taken the same day (Fig. 9). The Nile perch's postcranal segments were roasted on coals of the other hearth, and some of its cranial elements were disarticulated and boiled in the kerosene tin. The large catfish was gutted and decapitated in the fish-processing area and the head and body were roasted on the stoneless hearth. Small and medium-sized fish of all taxa were boiled in the kerosene tin. Northeast of the hearths lay by-products of harpoon shaft and foreshaft manufacture (Fig. 8).

On the fourth day of the occupation, for reasons unknown to us, a third hearth was set up 25 m northeast of the first two (Fig. 8), the hearth stones moved to it, and culinary processing thenceforth focused around it. By-products of culinary pro-

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FIG. 9. Site 10 catfish (*Clarias lazera*) head and Nile perch (*Lates niloticus*) opercular unit roasting on hearth.
cessing and ad hoc tools used in extracting tissue from bones were dropped near and discarded in a toss zone around the hearth. Debris included cranial fragments of a zebra scavenged from a lion kill, remains of at least two terrapins, fish cranial bones and vertebrae, two battered quartz cobbles, and two oryx horn sheaths. About 16 m to the west of this hearth, a crocodile-processing area developed, where lay discarded skulls, in one case with scutes of the back skin still attached, and other bones (Fig. 8).

A cluster of hind-leg bone fragments of the scavenged zebra lay about 19.5 m southwest of the third hearth (Fig. 8), mingled with the cranium of an oryx, bovid bones, and fish and turtle bones. A quartz cobbles lay about 2 m south of this bone concentration. It is possible that this area is a peripheral processing area first created when the original hearths were in use but utilized for the entire span of site occupation.

**Effects of Processing Activities on the Bone Assemblage**

The Site 10 faunal assemblage reflects both prey choice and processing activities in its species composition, bone preservation, and modifications. Proportional representation of taxa by MNI are generally similar to those of the fish and reptile individuals documented as taken, except in the case of the donated *Bagrus* (Table 4). Two to four individuals of this taxon were removed from the camp when the group left to forage farther south.

Although all fish were brought into the site whole, skeletal element representation in the remnant assemblage departed markedly from natural skeletal frequencies. Moreover, different species and body sizes within species were variably affected by preliminary processing and culinary handling, with moderate to heavy attrition of bones in certain body segments. Most striking was the absence of siluriform vertebrae (Table 5) in the sample; catfish axial bones were seen in units being roasted at the site, so these elements were not discarded before the fish were brought to the site. Stewart (1991) noted similar but less extreme biases against siluriform vertebrae in modern land surface collections and in fossil assemblages unaffected by hominids (Table 2, Fig. 4), probably reflecting the inherent fragility of these elements. Culinary processing by humans, especially exposure to fire, likely exacerbates the intrinsic fragility of catfish vertebrae, rendering them more prone to destruction by consumption or postdiscard trampling. It is also possible that some catfish axial segments were dried with vertebrae in and transported away from the site. Catfish cranial elements were preserved, but attrition was also considerable (Table 5).

Perciform skeletal element representation reflects differences in processing of large versus small individuals with the same anatomy. Though bones of the large *Lates* were roasted in their body segments, cranial and vertebral fragments appear to have been equally affected by culinary processing. Elements of fish >30 cm total length occur in proportions generally resembling those of the perciform skeleton, with more cranial and fewer vertebral elements (Stewart & Gifford-Gonzalez 1994).

By contrast, for perciforms <30 cm total length, about 92% of the cranial elements predicted from the number of fish brought to the site are missing, and vertebrae dominate. Perciform fish of this size range are well represented by cranial specimens at other sites in the sample, so the paucity of cranial elements at Site 10 cannot readily be explained by invoking inherent bone fragility. Selective migration of bones into the site’s sediments, as documented with Site 20's loose, sandy substrate (see next section), is unlikely, given Site 10’s hard lacustrine silts. Bones
trampled at Site 10 were more liable to be

damaged or destroyed than to deposited.

Waste disposal was not observed dur-

ding visits to the camp but some evidence

suggests that bones were dumped into the

nearby stand of sedges. When Gifford-

Gonzalez revisited Site 10 2 years later,

the lake level had dropped and the sedge

stand was dry and dead. Poorly preserved

fish and reptile bone fragments lay among

the sedges. These may have been bones

from Site 10 but were in too poor condi-

tion to lift for study. Smaller perciform

fish at Site 10 were cooked by boiling, and

our experience with preparing specimens

in this size range indicates that cranial

bones dissociate almost immediately in

boiling water. Subject to longer stewing,

dissociated bones that collected at the bot-

tom of the container could be dumped en

masse.

**TABLE 4**

Taxa Represented at Sites 06, 10, and 20: Species NISP and MNI

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Site 06</th>
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<th>Site 10</th>
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<tr>
<td></td>
<td>NISP</td>
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<td>%</td>
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</tr>
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<td>Oryx gazella</td>
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<td>2</td>
<td>2.7</td>
<td>7.4</td>
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</tr>
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<td>Gazella granti</td>
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<td>1</td>
<td>1.4</td>
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</tr>
<tr>
<td>Bovidae indet.</td>
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<td>n/a</td>
<td>n/a</td>
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</tr>
</tbody>
</table>

Note. Original number of individuals taken is given, if known. Site 20 data are excavated fish and reptile NISP, not original surface survey, since many specimens originally enumerated as articulated units (e.g., carapace) were recovered as dissociated elements. *scavenged for food; **scavenged for tool making; †includes neonate scavenged or hunted for food; ‡present originally.
mented, displaying the damage associated with extracting neural tissue observed by Stewart (1991) at the Turkana camp AS1; some siluriform crania were intact. Cutmarks were not noted in the 1973 analysis, and the bones were too weathered at later checks to assess such modifications.

**Longer Term Taphonomic Observations**

Condition of fish, reptile, and mammal bones at Site 10 was checked in 1976, 1978, and 1980. Disintegration of fish bones was noted within the first 2 years (Fig. 10), and reptile bones of even the largest crocodiles were also in poor condition (Fig. 11), compared to mammal bones, which were at Weathering Stages 1 and 2 in 1976 (cf. Gifford-Gonzalez 1984). A similarly swift rate of fish bone degeneration was seen at Site 06, situated on a very different substrate (see Site 06 below). The largely intact mumified zebra carcass ultimately was disarticulated by carnivore consumers after heavy rains in March, 1974, and its remains were scattered through the Site 10 bone distribution. None of its bones were broken, nor did they bear any human processing marks, however, presence of these elements would present interpretive challenges (see Discussion).

### Site 20: A Short-Term Base Camp

**History**

Site 20 was created on November 11, 1973 by the same foraging party of eight who had camped previously at Site 10. It lay 5.5 km south of Site 10, in a small delta complex of an ephemeral stream, the Il Arap Mehto, about 400 m inland from the extant lake shore (Fig. 1) and behind a remnant beach ridge of the 1970 lake high stand, then dissected by the Arap Mehto distributary channels. The men stayed at the camp for 4 days, abandoning it to head south to the Allia Bay area on November 15. Gear brought to Site 20 was the same as that used at Site 10, with additional harpoon shaft items made at the previous camp.

During their 4 days’ stay at Site 20, the party obtained 12 catfish (*Clarias*), four tilapia, and two Nile perch and imported the *Bagrus* carried from Site 10. Many more reptiles were obtained here than at Site 10. The party dug 40 estivating terrapins (*Pelusios adansonii*) from a mud slough near the lake and caught four crocodiles. They also scavenged meat from two zebras killed by lions. Processing and cooking was not closely documented at this camp, although daily increments of fish, reptile, and mammal foods were

### Table 5

<table>
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<th>Body Segment:</th>
<th>Cranial</th>
<th>Axial</th>
<th>Epaxial</th>
<th>Total</th>
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</thead>
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<tr>
<td>Site 20 Siluriformes</td>
<td>163</td>
<td>63.7</td>
<td>48</td>
<td>18.8</td>
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<tr>
<td>Average Siluriform Elements</td>
<td>62</td>
<td>49.6</td>
<td>60</td>
<td>48.0</td>
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<tr>
<td>Site 10 Perciformes</td>
<td>81</td>
<td>57.9</td>
<td>42.1</td>
<td>59</td>
</tr>
<tr>
<td>Site 20 Perciformes</td>
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<tr>
<td>Average Perciform Elements</td>
<td>83</td>
<td>63.4</td>
<td>27</td>
<td>20.6</td>
</tr>
</tbody>
</table>

*Note.* Expressed as percentages of bone elements (MNE), by body segment. Note that Site 10 lacks enumeration of epaxial elements (see Methods).
noted during brief visits. Large and small catfish were roasted rather than boiled. The hind leg of one zebra and meat from the forequarters of another were processed.

The Site 20 bone assemblage was mapped and identified in the field on November 16, the day after the camp was abandoned. Site 20 was inundated in late March and early April, 1974 by a succession of flood events in the Arap Mehto drainage. Materials in the main channel were carried off by vigorous flow, while those on the channel edges and side channels were capped in finer grained silts and effectively cemented in place by a few days’ drying in sunny weather before the next, more vigorous flood event buried the site completely. In August, 1974, Gifford-Gonzalez excavated the center of the site (Fig. 12) and analyzed the recovered bone assemblage (Gifford and Behrensmeyer 1977). Bones in the side channels were largely in the same places and orientations as when originally mapped, due to their initial capping in late March. A few elements along the main channel margin showed evidence of hydraulic transport and reorientation (Gifford and Behrensmeyer 1977).

The excavation revealed additional information on site formation, as previously reported by Gifford and Behrensmeyer (1977). The recovered assemblage was about 40% larger than that originally mapped on the surface, even though the excavated area was less extensive. The taxonomic composition remained the same as in the initial surface inventory, but fish ribs, pterygiophore spines, and fin rays were much more common in the excavated sample. Because these elements were encountered within the sandy matrix capped by the flood event silts, it was inferred that they migrated into the loose site substrate during occupation of the

FIG. 10. Site 10: Nile perch (*Lates niloticus*) hyomandibular; weathering after 2 years’ exposure (white bar = 1 cm).
camp due to trampling by the occupants (see also Gifford-Gonzalez et al. 1984).

Processing Activities and Site Structure

The Site 20 camp was set up at the junction of the Arap Mehto's main channel with two side channels, all of which offered open sandy substrates amidst spike grass tussocks (Fig. 12). Most of the bone was concentrated in drop and toss zones around a single hearth. Three cooking pot supports of gastropod conglomerate sandstone were gathered anew at this location; low outcrops of the stone about 2 km south were the probable source of the Site 20 hearthstones. The sandy side channel west of the hearth was a rest area, kept relatively free of large bone debris and furnished with a large lake weed (Potamogeton sp.) "pillow" (Fig. 12). The scavenged zebra leg and flesh lay at a meat-drying area about 10 m up the main channel from the central site scatter.

Effects of Processing Activities and Depositional Events on the Bone Assemblage

The excavated 2960-specimen fish and reptile assemblage was studied by Stewart and Rybczynski, permitting comparison of fish bone modifications to those observed by Stewart among Turkana fishers at the AS1 site. Rybczynski's detailed analysis of the reptile bones permits generalizations about handling of these taxa. (This article reports data presented in Rybczynski et al. 1996, but uses a different approach to aggregation of elements into body segments and hence displays different statistics.)

Like Site 10, this is a relatively low-diversity fish assemblage, reflecting the foragers' focus on a few prey species, but,
like Sites 03 and 10, the mix of mammal, reptile, and fish taxa is remarkable, especially given the 4 days' duration of accumulation. Table 4 shows that the assemblage is dominated by *Pelusios*, accurately reflecting the original take. The *Crocodylus* MNI calculated from the excavated sample was higher by one than the original number documented. Whether this is due to incorporation of "background" land surface bone in the excavated sample or to an error in estimating the number of crocodiles in 1973 is unknown. Fish MNI statistics are generally representative of those caught (Table 4). A single specimen each from bird and mammal classes were recovered. These were weathered and may represent "background" bone in the area, since neither were originally enumerated in the surface documentation of the site in November, 1973. Only 7.9% of the excavated specimens from Site 20 were entirely unidentifiable.

Skeletal element representation at Site 20 shows similar trends to those at Site 10 (Table 5). Siluriform vertebrae were underrepresented, but not to the same extreme degree as at Site 10. Nearly all fish cranial elements derived from catfish, about 29% of which were broken in half and another 14% more heavily fragmented. Comparing the number of catfish
cranial elements predicted from the individuals actually taken to their NISP in the recovered sample (adjusting for area excavated), deletion of about 61% of the original complement is apparent. As at Site 10, smaller perciform cranial elements were underrepresented relative to vertebrae (Table 5).

Again, like the Site 10 bones, taxon and size conditioned frequencies of various modifications to Site 20 fish and reptile bones. Most of the burned fish bones were from siluriforms, consonant with the tendency to roast catfish, but not perciforms seen at Site 10 and at AS1 (Table 6). Cuts and slicing marks on Site 20 fish bones were virtually nonexistent (Table 6), contrasting with FC1 and AS1. This may be a product of the lower proportions of perciforms at Site 20, which taxa most commonly bear cut marks at the other sites (Stewart and Gifford-Gonzalez 1994).

*Pelusios* MNI in the excavated assemblage account for only 40% the original number of 40 individuals taken or the 39 enumerated in the 1973 surface mapping (Table 4). [To check this result, Rybczynski calculated the MNI by two methods: enumerating appendicular elements and by summing carapace plate elements and then dividing by the average number of plates found in an average single carapace (48). Both methods produced the same estimate.] Some corrections for excavation sampling and fluvial transport should be made. Mapped specimens that lay outside the excavated zone (MNI = 14; Fig. 12) were not retrieved, nor were those originally in the main channel (MNI = 4) and carried off in the first flood event (Gifford and Behrensmeyer 1977). The predicted MNI based on carapace count for the excavated area is thus 21, whereas the recovered sample yielded a MNI of 16.

Because mapping and enumeration of *Pelusios* had taken place after culinary processing and discard, this 25% difference is best attributed either to scavenging animals (jackals showed an active interest in excavated bones during the 1974 dig) or, more likely, to hydraulic transport during the more vigorous of several flood events inundating the whole site. Whole terrapin shells are very stable in flowing water and

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<th>FC1</th>
<th>AS1</th>
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<td>Perciform</td>
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<table>
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<td>0</td>
<td>1</td>
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</tr>
<tr>
<td>Axial</td>
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<td>Epaxial</td>
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<td>Σ Cut</td>
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tended to bury themselves in substrate during flume experiments (Gifford and Behrensmeyer 1977). However, dissociated turtle shell segments have high surface-area-to-volume ratios, placing them in Voorhies Transport Category I, the most likely to be carried away in flowing water (Voorhies 1969; Behrensmeyer 1975; Rybczynski et al. 1996).

Modifications to reptile bones varied according to species, though both terrapins and crocodiles had relatively high rates of charring. *Pelusios* bones accounted for 44.6% of the total site NISP but 54.1% of all burned specimens; the vast preponderance of burned terrapin elements were carapace and plastron segments (Table 7). Terrapins were roasted whole in the fire, their plastrons then cut or pried apart from their carapaces, leaving most of the internal muscles and organs in the bowl-like upper shell.

Slices rather than cuts occurred on 5% of terrapin elements, the greatest absolute number of such marks in the assemblage, and were concentrated on the upper and lower shells (Table 7). Since shells lack nourishing tissues on their exteriors, slice marks testify to forcible opening. Forty-five were on carapace segments and 23 on plastron elements. This proportion may be misleading, because slice marks on the carapace tended transect several adjacent bones, which then dissociated after discard and were counted individually, thereby inflating the rate of slice marks on carapace elements. Slices on plastrons clustered on the lateral section of the hypoplastron, where it forms a bridge to the carapace, so that one act of cutting produced a single mark.

As with terrapins, crocodile specimens tended to bear a somewhat disproportionate share of burning, comprising 15% of assemblage NISP, but 23% of all burned bones (Table 7). Burning was concen-
trated on cranial and axial (including dermal scutes) bones, nearly evenly divided between the two, with only 2% encountered on appendicular segment bones (Table 7). High burning rates on these bones poses interpretive questions that were not dealt with by interview or observation. Discard of crania and scutes early in butchery has been described for the same foraging party at Site 10. Crocodile heads have virtually no muscle and very little neural tissue within a thick brain-case, so they do not repay the handling effort of cooking and breaking. The Site 20 cranial bones may have been burned to reduce their attractiveness to scavengers patrolling the area.

Contrasts in occurrence of slices and cuts on bones of *Crocodylus* versus *Pelusios* stem from the differing size and anatomy of the taxa (Table 7). Crocodiles, particularly larger individuals, must be butchered into segments and/or filleted for cooking. While relatively rare, cut marks are more common on crocodile bones than on those of other taxa (Table 7), most on vertebrae and probably inflicted during filleting. Slice marks, reflecting forceful cutting, occurred on only three *Crocodylus* bones. Once their tough hide is breached, even large crocodiles’ legs can be disarticulated by leverage and selective cutting of connective tissue.

Deletion of terrapin cranial and appendicular skeletal elements may reflect their destruction during cooking and consumption (Table 8). The inflation of crocodile cranial elements relative to their frequency of occurrence in the skeleton reflects dissociation of the multielement crania and mandibles after burial and recovery of their constituents as isolated elements.

The recovered mammal bone reflects neither type nor amount of mammal tissue obtained.

A Longer-Term Foraging Camp: Site 06

**History**

Site 06 was created over 6 weeks in July and August, 1973, just before Gifford-Gonzalez began her fieldwork, by an impoverished Dassanetch couple. Information on the inhabitants, their equipment, and foraging practices was provided by Kamoya Kimeu (personal communication, 1973), leader of the National Museums of Kenya’s fossil search team. Gifford-Gonzalez mapped the bones and identified them in the field November 13–15, 1973, leaving fish and reptile elements in place to monitor weathering and collecting most mammal boned for further modification analysis. Site 06 was the only site in the sample not created by an all-male foraging party, and
some aspects of site organization and gear reflect the presence of a Dassanetch woman.

Gear noted by Kimeu included a small fish net, a spear and/or a harpoon, a metal knife, a cooking pot, and a crude grinding stone from poorly consolidated local sandstone, apparently used to process sedge roots, some of which still lay next to it when mapped. Information on acquisition and processing of animals is lacking and can only be inferred from the remains themselves. The man was said to set his net mornings at a small inlet of the lake near camp and to check the sky for vultures circling lion kills (Kamoya Kimeu, personal communication, 1973). Two adult topis are represented by some body segments, probable results of scavenging. A neonate to 2-week-old Grant’s gazelle and a 2- to 12-week-old zebra foal are represented by bone fragments from nearly all body segments. Each probably was acquired by direct predation, since bone of such small individuals would readily have been consumed by carnivores as small as jackals (cf. Gifford-Gonzalez 1989).

Processing Activities and Site Structure

The site’s structure was determined in part by its location on a flat-topped, stabilized sand dune some 20 m above and 300 m inland from the shore line, where, in contrast to the littoral, dune vegetation included a Salvadora persica tree and some low shrubs.

Two aspects of internal organization set Site 06 apart from other foraging camps in the 1973 sample. First, the central focus of activities was a shelter dug in the loose sand under the weeping willowlike boughs of the Salvadora tree (Fig. 13). Sitting areas and bone scatters lay in the morning and afternoon shade of the tree. One hearth lay in the morning shade area (Fig. 13). Second, the space under the...
tree’s boughs was organized similarly to a Dassanetch house, which women construct and maintain. To the left as one entered was a hearth with three hearth-stones; Dassanetch women customarily place the hearth “on the side of women” to the inside left of the doorway (Gifford 1977; Gifford-Gonzalez 1989). The grindstones and sedge roots were found in this side of the shelter.

To the northwest of the domestic space lay an area for working on oryx horn sheaths gathered from the landscape (Fig. 14). A shrub about 20 m north of the tree was the focus of fish processing and served as a drying rack, its location contributing substantially to the overall dimensions of the site (Fig. 15).

**Effects of Processing Activities on the Bone Assemblage**

Fish taxa at Site 06 are more diverse than at other sites (Table 4), not unexpectedly, given that the longer duration of stay increased chances of sampling more species. As at Sites 10 and 20, the species represented at Site 06 all littoral-adapted, including the small *Bagrus*, as juveniles of this species spent their early development inshore (Hopson 1982).

Siluriform cranial element representa-
tion is similar to that in the Site 10 assemblage. However, element frequencies for perciforms at Site 06 differ substantially from those at Sites 10 and 20. Perciform vertebral elements are very underrepresented relative to Sites 10 and 20 (Table 2). Alternative explanations for this difference may be proposed. First, Gifford-Gonzalez did not count individual vertebrae in articulated rows left in the field. In later analysis, an average number of vertebrae per row was estimated based on site photos, and this tactic could have underestimated the actual number present at Site 06. Second, lack of vertebrae may result from drying and transporting perch bodies away from the camp. The FC1 and AS1 camps (see below) were geared to dry fish for transport to other locales. There, axial segments were split and dried with vertebrae left in and when these were taken from the sites, most vertebrae were deleted from the local assemblage. Similar activities on a more limited scale at Site 06 may have had a similar effect.

About 58% of the fish braincases at Site 06 were broken into anterior and posterior halves, in the same brain-extraction pattern documented at other sites. About half the broken skulls were Nile perch and the
balance were catfish species; none of the small Oreochromis (formerly Tilapia) skulls were broken.

Fish bones at Site 06 were monitored by Gifford-Gonzalez for 10 years after the initial mapping. Ten years after exposure, even the largest Nile perch bones on the site surface were on the verge of disintegration (Fig. 16). Crocodile bones were also in advanced states of weathering (Fig. 17). By contrast, vertebrae of the neonate Grant’s gazelle were at Behrensmeyer’s (1978) Weathering Stages 3 and 4. Detailed information on mammal bone modifications can be found in Gifford-Gonzalez (1989).

FC1: A Dassanetch Fish-Processing Camp

In 1985, Stewart documented FC1, a Dassanetch fishing camp, on the same section of littoral surveyed by Gifford-Gonzalez (Fig. 1). It contained about 2600 bones distributed over 10 by 20 m (Stewart 1991). The site was not observed during occupation, but Stewart interviewed galáries fishermen on their processing practices. As at foraging camps documented by Gifford-Gonzalez, the FC1 fish fauna was a restricted range of perciforms and catfish (Table 1). In contrast to all Dassanetch sites but Site 06, the FC1 assemblage had very low frequencies of larger fish vertebrae (Table 2), as was the case at the Turkana AS1 fish-drying camp. This supports informant-based testimony that FC1 was predominantly a fish-drying camp.

Burning (Table 6) was concentrated on anterior elements of large fish skulls, reflecting roasting of heads and paralleling that seen at AS1 (see below). Elements from smaller fish generally showed differentially higher rates of burning than did...
those of larger fish (ca. 20% versus ca. 6%, respectively). Catfish elements had low burning rates, but as at other sites charring was equally represented on cranial and vertebral bones, reflecting different handling of siluriforms and again raising the possibility of burning-mediated destruction of vertebrae.

Cuts were noted on about 4% of fish bones at FC1, nearly all on those of cichlids (Table 6). Most lay on the lateral regions of the skull, reflecting disarticulation of cranial units from the braincase, and on the posterior of the braincase, reflecting detachment of head from vertebrae. As at other sites, body size conditioned the occurrence of cutmarks; only one cut was noted on fish <30 cm total length (Fig. 17).

AS1: A Turkana Fish-Processing Camp

Table 6 presents data from AS1, published and discussed in greater detail in Stewart (1991) and Stewart and Gifford-Gonzalez (1994). Vertebral elements were very rare, especially for siluriform elements, where deletion by transport of backbones away from the site in dried body sections may have exacerbated in-place destruction by roasting. Burning occurred on about 11% of fish bones, in patterns similar to that in the FC1 assemblage, with most on anterior cranial elements of larger perciforms, reflecting the roasting of fish heads for immediate consumption while drying the rest of the bodies.

All cuts and slices in the AS1 assemblage were on bones of Nile perch over 100 cm long. This size class lacked most vertebral elements, precluding evaluation of cuts on that body segment. About 70% of cutmarks in the extant axial sample were shallow, fine striations near the midline on ribs, suggesting infliction during filleting. Deep slices were rarer

FIG. 17. Site 06: crocodile (Crocodylus niloticus) humerus; weathering after 10 years’ exposure (white bar = 1 cm).
and clustered on rib shafts, suggesting damage during preliminary sectioning of the body into segments. The next densest concentration of cutmarks was in the cranial area, primarily on postcleithral elements, where 17% of specimens bore cuts on distal ends, probably made during detachment of the head. Three of the remaining seven cuts and slices on AS1 fish bones lay on the parasphenoid, on the ventral side of the braincase: they were deep and probably reflect attempts to hack into the neural cavity ventrally. The balance of cuts lay on various body segments, presumably made while sectioning the body.

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