TAPHONOMIC INDICATORS USED TO INFER WASTEFUL SUBSISTENCE HUNTING IN NORTHWEST ALASKA

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Summary

Subsistence hunting allows the Inupiat and Yupik people to harvest walrus. Hunters pursue walrus at the edge of the receding ice floes, or if the opportunity arises, will shoot walrus in the open water (pelagic hunting). Based on recent 9th District Court decisions, killing walrus and taking only the tusks is a violation of the wastage provision and is penalized by law. Surveys conducted on beaches indicated that some walruses are hunted only for their tusks (headhunting). The determination that the walruses are killed off shore is based on the "clean" appearance of exposed cervical vertebrae caused by arthropod scavenging during carcass drift. The conclusion of wasteful take is based on the examination of headless carcasses that had no meat taken.

Résumé

Indicateurs taphonomiques utilisés pour mettre en évidence le gaspillage dans la chasse de subsistance dans le nord-ouest de l'Alaska.

La chasse de subsistance autorise les Inupiat et les Yupik à chasser le morse. Les chasseurs poursuivent les morses à la limite de la banquise flottante, ou bien, si l'opportunité se présente, vont tirer les morses en pleine mer (chasse pélagique). D'après les décisions récentes du 9e District Court, tuer un morse et ne prendre que ses défenses est une violation du décret sur le gaspillage et est pénalisé par la loi. Des prospections conduites sur des plages ont indiqué que des morses ne sont tués que pour leurs défenses ("headhunting"). La mise en évidence que les morses sont tués au large est faite par l'aspect "propre" des vertèbres cervicales exposées, dû au nettoyage par les arthropodes pendant que la carcasse dérive. La conclusion de gaspillage est basée sur l'examen de carcasses sans têtes, sur lesquelles aucune viande n'a été prélevée.

Zusammenfassung

Taphonomische Merkmale zum Nachweis illegaler Jagd in Nordwest-Alaska.

Den Völkern der Inupiat und der Yupik ist es erlaub, zu ihrer Versorgung (Subsistenz) Walrosse zu erlegen. Die Jäger töten die Tiere an der Abbruchkante des Packeises oder - wenn sich die Gelegenheit ergibt - im freien Wasser (pelagic hunting). Nach einem Urteil des 9. District Courts wird das Erlegen von Walrossen gesetzlich verfolgt, wenn das Töten nur wegen des Elfenbeins erfolgt. An den Stränden durchgeführte Untersuchungen haben ergeben, daß zahlreiche Walrosse tatsächlich nur wegen des Elfenbeins getötet worden sind ("Kopfjagd"). Der Beitrag befaßt sich mit den Möglichkeiten der Deutung von Walroßkadavern: Subsistenzjagd oder illegale Jagd auf Elfenbein?

Key Words

Taphonomy, Subsistence hunting, Wastage, Poaching.

Mots clés

Taphonomie, Chasse de subsistance, Gaspillage, Braconnage.

Schlüsselworte

Taphonomie, Subsistenzjagd, Wilderei.

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Introduction

The Pacific Walrus (*Odobenus rosmarus*) is an important resource for the cultural and physical survival of Inupiat and Yupik natives of northwest Alaska. These native people of the Bering and Chukchi seas harvest walrus in the spring to meet subsistence needs for meat, hides and ivory. The native Alaskan subsistence harvest is legally granted under various laws and agreements. Legal subsistence harvesting mandates that walrus be used in the traditional manner and that waste of the resource does not occur. Based on recent 9th District Court decisions, killing walrus and taking only the tusks is a violation of the wastage provision (USA vs Clark, 1990). Within the last few years, the need for cash in native villages has led to abnormal economic pressures and to wasteful walrus hunting because of the high price of ivory.

Law Enforcement Agents of the United States Fish and Wildlife Service were asked to investigate stranded walrus carcasses to determine if there was evidence of wasteful and illegal killing during the legal subsistence hunt. Carcasses of walruses stranded on beaches may contain evidence of wasteful practices. This investigation did not address basic biological questions such as age, sex, population size, etc., but instead it focused on the forensic question of whether walrus are being harvested in accordance with the legal subsistence requirements or are they being killed only for their ivory tusks.

Objectives

The principal objectives were to:

1. count the number of walrus carcasses found stranded along the coast of the Bering Strait and southern Chukchi Sea and compare these observations with surveys from previous years;

and to

2. examine carcasses to infer place of tusk or head removal and determine if the harvest was wasteful.

Walruses are hunted along the retreating edge of the ice pack each spring as they migrate through the Bering Strait into the Chukchi Sea. Walrus may be shot as they sit on ice floes or opportunistically while they are swimming in open water. Full "traditional use" of a hunted walrus includes recovery of the hide, flippers, liver, heart, blubber, and ivory. It is wasteful by law to remove only the tusks or head from a hunted walrus (i.e., head hunting).

Methods

Aerosurvey

Beaches of the northern Bering Strait and the southern Chukchi Sea were surveyed in the summer of 1990, 1991, 1992, and 1993 (fig. 1). A Cessna 185 and a Piper Supercub were used to fly observers along the beach at 100 to 500 feet of altitude. Marine mammal carcasses were spotted, and the location recorded with Global Positioning Satellite (GPS) receivers along the flight path. The aerial survey results were compared with similar survey data from previous years (tab. 1). Coastlines inside barrier islands were not surveyed because of the low probability of carcasses drifting inland due to exiting surface currents.

Field examination

The coastal section between Cape Espenberg and Cape Wales was selected to examine each individual carcass in order to determine the condition in which the tusks or head was removed. The skull, if present, or the anterior cervical vertebrae was examined and photographed. If the tusks had been removed by chopping, the anterior portions of the frontal bone and the surrounding alveolar surfaces were examined. In carcasses with no skull attached, the surfaces or facets of the cervical vertebrae were carefully examined for evidence of knife cuts on the exposed surface.

The low number of walrus carcasses counted in 1990 and 1993 is consistent with the low numbers of walrus harvested during the spring hunt as reported by native hunters. The high number of walrus carcasses counted in 1992 is also consistent with a reported fruitful harvest during the spring and summer hunt of that year. The reason for the low harvest in 1990 and 1993 was the early and rapid retreat of the edge of the ice pack through the Bering Strait in the months of May and June (Brower *et al.*, 1988). Wal-

Table 1: Summary of current and previous walrus strandings for the beaches between Cape Espenberg to Cape Wales.

Year	Carcass count	Reference
August 1993	32	
August 1992	165	
August 1991	70	
August 1990	33	
August 1989	91	3
September 1988	131	2
July 1976	57	11
July 1975	91	10

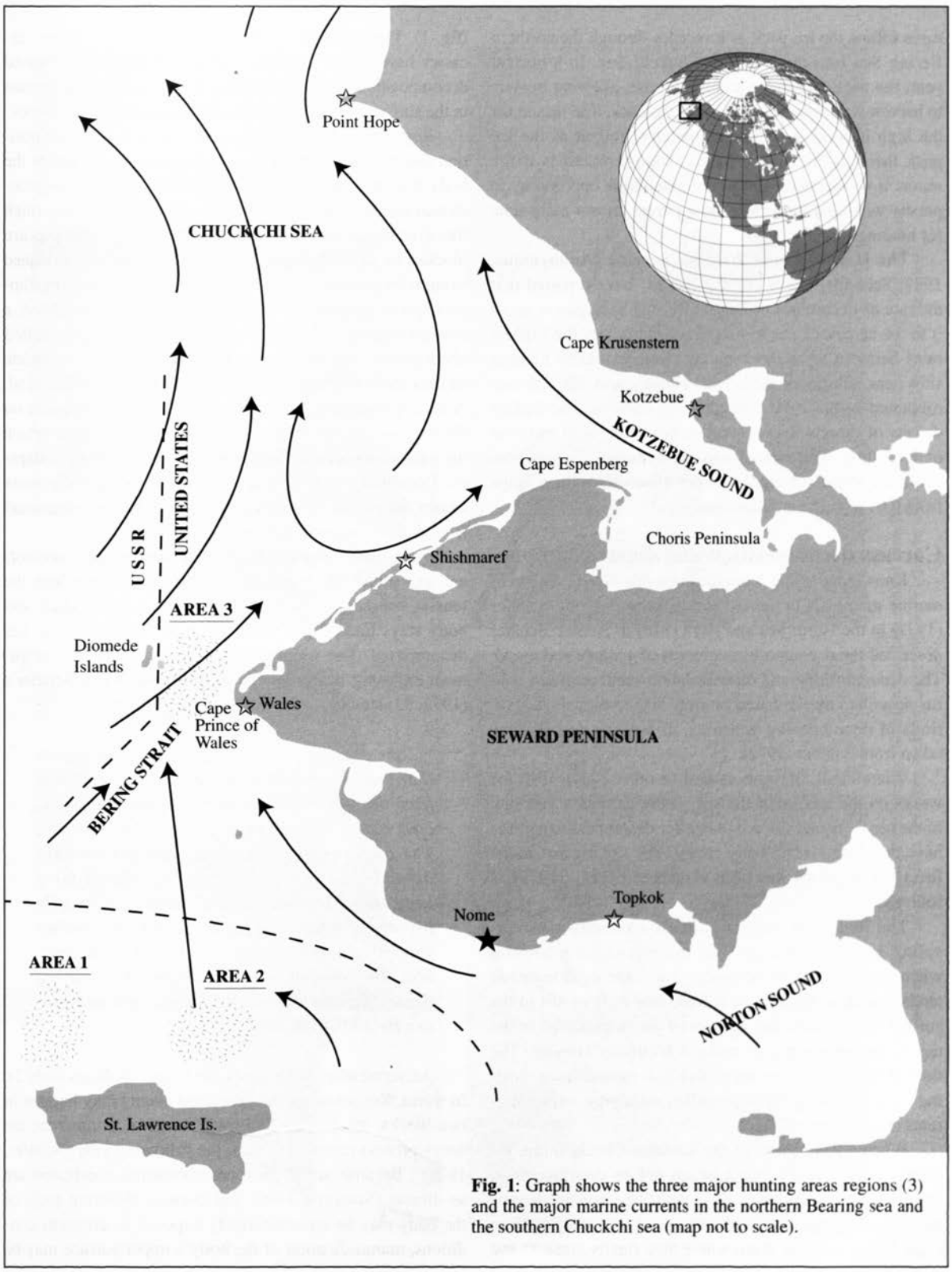

Fig. 1: Graph shows the three major hunting areas regions (3) and the major marine currents in the northern Bearing sea and the southern Chuckchi sea (map not to scale).

ruses follow the ice pack as it recedes through the northern Bering Sea into the southern Chukchi Sea. In a normal year, the pack recedes at a constant rate, allowing hunters to harvest walrus at the edge of the ice pack. The reason for the high harvest in 1992 was the slow retreat of the ice pack through the Bering Strait. The net result is if the retreat is accelerated, hunters are given little opportunity to pursue walruses, whereas a slow retreat allows more time for hunting.

The U.S. Fish and Wildlife Service (Anonymous, 1989; Schliebe, 1989) and Fay (1978) have reported that the rate of occurrence of beach-stranded carcasses is about 0 to 14 carcasses per kilometer of shoreline, the highest rates being in areas down current from extensive hunting sites near villages of the coastal natives, and this was corroborated in the 1990 through 1993 surveys. The highest density of carcasses was found east of Shishmaref and west of Kividlow. The rate of carcass occurrence elsewhere averaged about 0.5 carcasses per kilometer with a range from 0.01 to 0.15 per kilometer.

Carcass decomposition and disarticulation

Knowledge of the decomposition and disarticulation of marine mammals is limited to the work done by Schäfer (1972) in the North Sea and Fay (1978) in Alaska. Schäfer described the decomposition process of a whale and a seal. The decomposition and disarticulation sequence for a walrus described here is based on over 500 empirical observations of decomposing walruses, as well as descriptions taken from Schäfer (1972).

Walrus that die from natural or other causes drift for weeks on the surface of the sea. These carcasses first sink to the sea floor and surface only after decomposition gasses have developed in the body cavity. The sinking and resurfacing of a carcass has been explained by Fay (1978) as follows.

The bodies of marine animals during late winter, spring and early summer tend to be negatively buoyant when divest of air in the lungs. Thus, the dead mammal tends to sink to the bottom at first, then to float just to the surface after a sufficient amount of gas is produced in the tissues by putrefaction to make it positively buoyant. The drift of the sunken carcass probably is minimal; the floating carcass presumably is propelled mainly by surface currents (Fay, 1976; 1977).

When a walrus dies in the Southern Chuckchi sea, the corpse generally reaches a beach before decomposition begins (fig. 2). Carcasses float with the eastward marine currents along the coast and are carried onto beaches from Cape Wales to Point Hope where they finally come to rest (fig. 1). The surf then washes it on to the sand. These carcasses have a red - pinkish coloration even after advanced decomposition has occurred (fig. 2). Carcasses that remain in the surf area appear grayish-white after about two weeks.

Regardless if a carcass is headless or not, decomposition causes bloating with such high gas pressure inside the body that the corpse turns into a firmly inflated, torpedo-shaped barrel. Decomposition gasses do not escape through the esophagus or the anus because both opening are blocked by distended tissues. The whole body is stretched straight by this uniform internal pressure and the fore-flippers spread perpendicular from the body. While bloated, a headless carcass is easily moved by the surf and rolled about on the sand by waves. On the other hand, a complete carcass tends to anchor with the tusks lodged in the sand. After approximately 20 to 30 days, sea gull predation on the carcass creates deep scavenging holes through which the gasses escape, and shortly after the body cavity collapses. Eventually, the weight of the collapsing body mass causes the ribs of the body to press against the integument from within, and eventually pierce the skin.

Field observations indicate that the manus (forefoot) and pes (hindfoot) tear away first, particularly where the tensile stresses are strong. The connection of skull and body stays undamaged until the great mass of tissue has decomposed. The weight of the flippers tears the integument exposing disarticulated limb bones. As in Schäfer's (1972: 23) studies,

> "*...the body cavity opens, the gasses and liquids that have been collected during decay escape from the carcasses together with the highly viscous oils derived from the subcutaneous layers. The outflowing oils form a dark brown halo around the body which stays discolored for a long time. The oil soaked sands eventually become slab-like concretions which may outlast transportation as individual, round-edged pebbles. The same oils also penetrates the decaying tissues, prevent their rapid liquefaction and protect the body from maggots*".

Arctic weather determines the length of decay (tab. 2). In warm, wet summers the described events may happen in two weeks, whereas cold temperatures will interrupt the decay process completely until the following year (Schäfer, 1972) . Because arctic microenvironmental conditions are so diverse (Sutcliffe, 1990) and because different parts of the body may be simultaneously exposed to different conditions, mummification of the body's upper surface may be

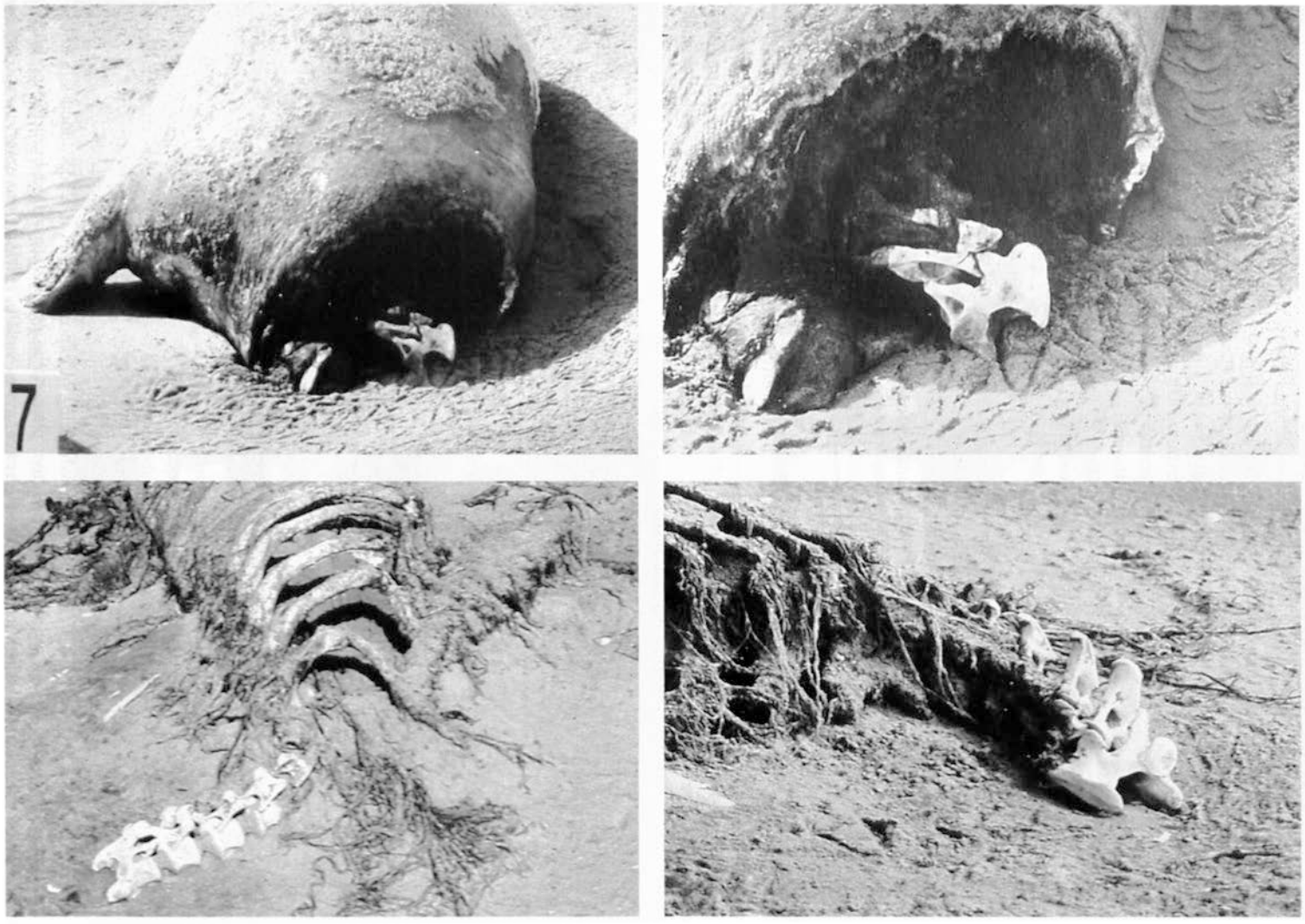

Fig. 2: Top Row: Beached disarticulated headless carcass that exhibit bleached exposed vertebral bones. Bottom Row: Same carcass on year later showing skeletonized remains. Vertebrae still appears weathered and bleached.

Table 2: Mean air and sea surface temperature in the Bering Strait (9).

Month	Mean Air Temperature in Centigrades (S.D.)	Mean Sea Surface Temperature in Centigrades (S.D.)
May	2.8°C (4.6)	-0.7°C (1.2)
June	3.2°C (3.6)	2.4°C (2.2)
July	7.3°C (3.3)	5.4°C (3.2)
August	7.5°C (2.9)	7.1°C (3.2)
S.D. = standard deviation		

combined with complete chemical decomposition of the underside.

On whole carcasses (i.e., with head) skeletal disarticulation begins with the manus and pes, and lastly the head is severed from the body mass. Readily observable exposed bones appear oily and retain residues of ligament, tissue and cartilage even after 1 year (fig. 2). Once the thoracic cavity of the carcass has collapsed, offshore winds will fill the body cavity with sand, partially burying it. These will remain buried until future offshore winds expose the skeletonized remains (fig. 2). We have observed partially mummified, skeletonized carcass become unburied by offshore winds, leading to eventual disarticulation and reburial. Waterborne carcasses that stay in the surf will be subjected to mechanical tearing of the limbs, and will decompose and disarticulate rapidly.

Field examination

Walrus carcasses that were examined in the northern coast of the Seward Peninsula, between Cape Wales and Cape Espenberg, were found to be deposited usually on sandy/rocky beaches at the high tide boundary, unless storms deposited the carcasses on the permafrost. About 80% of the carcasses were headless; some carcasses exhibited dismemberment of the flippers. Other post-mortem modifications noted were sea gull scavenging which produces round wounds that penetrate through the blubber. Although bears frequent the beaches, only one carcass had evidence of bear scavenging. Presence of diptera insects is only seen in proximity to human habitation and was absent in other areas. The majority of the carcasses either had not begun to decompose, or they exhibited signs of early decomposition.

Stranded walrus carcasses showed evidence that the rate of decomposition varies within a single carcass. When cervical vertebrae were exposed, they appeared white as in extreme weathering. The vertebral surfaces showed no sign of cracking or flaking as would result from weathering, (taphonomic stage 0, Behrensmeyer, 1978). The carcasses also exhibited early decomposition as indicated by the reddish-white coloration of the skin. Therefore, although exposed cervical vertebrae suggested a long weathering period, the rest of the carcass inferred recent decomposition. Because of these irregularities, we conducted an actualistic study by placing articulated cow bones in three micro-environments: (1) marine subsurface (i.e., submerged), (2) tidal, and (3) partly vegetated rocky, sandy beach.

The following observations were consistently noted in studies conducted in two locales: the Pacific Ocean off the Oregon coast and in the northern sea off the coast of Nome, Alaska. Each study consisted of fresh, partly fleshed, articulated bones exposed to three different environments for 35 days (Oregon) and 19 days (Alaska).

(1) Bones that had been exposed to a marine subsurface environment (submerged) were clean of muscle, ligament, cartilage and blood staining. The bones were disarticulated and appeared bleached, white and free of any visible organic film (fig. 3).

(2) Bones that had been exposed to a tidal environment with intermittent periods of submersion, wave activity, and wind/sun drying retained residues of muscle, ligament, and cartilage. The bones were still articulated and appeared oily, blotchy, and had blood stains (fig. 4).

(3) Bones that had been exposed to a beach environment retained residues of muscle, ligament and cartilage. The bones that had tissue were still articulated, stained with blood, and appeared very dry (fig. 5).

The conclusion drawn from these studies is that bones that are submerged for 19 days in the Bering Sea become disarticulated and have a physical appearance quite different from bones exposed to the tidal zone or above the tidal zone. These findings were reproduced in the study conducted off the coast of Oregon. This taphonomic macerating and weathering study indicates that the whitening of exposed bones is a reproducible and consistent phenomena probably assisted by arthropod and fish scavenging (Smith, 1986). Conversely, exposed bones that contain residual ligament and muscle, and which

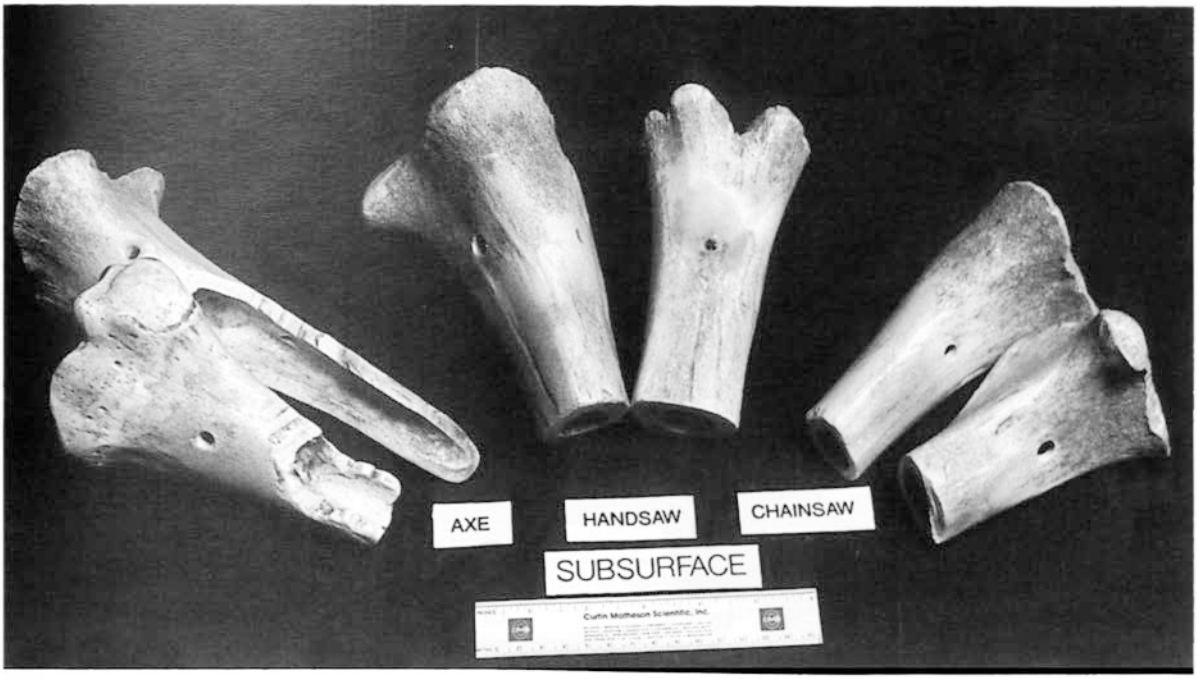

Fig. 3: Fresh, partly fleshed, articulated bones that had been exposed to a marine subsurface environment (submerged) were clean of muscle, ligament, cartilage and blood staining. The bones were disarticulated and appeared white and free of any visible organic film.

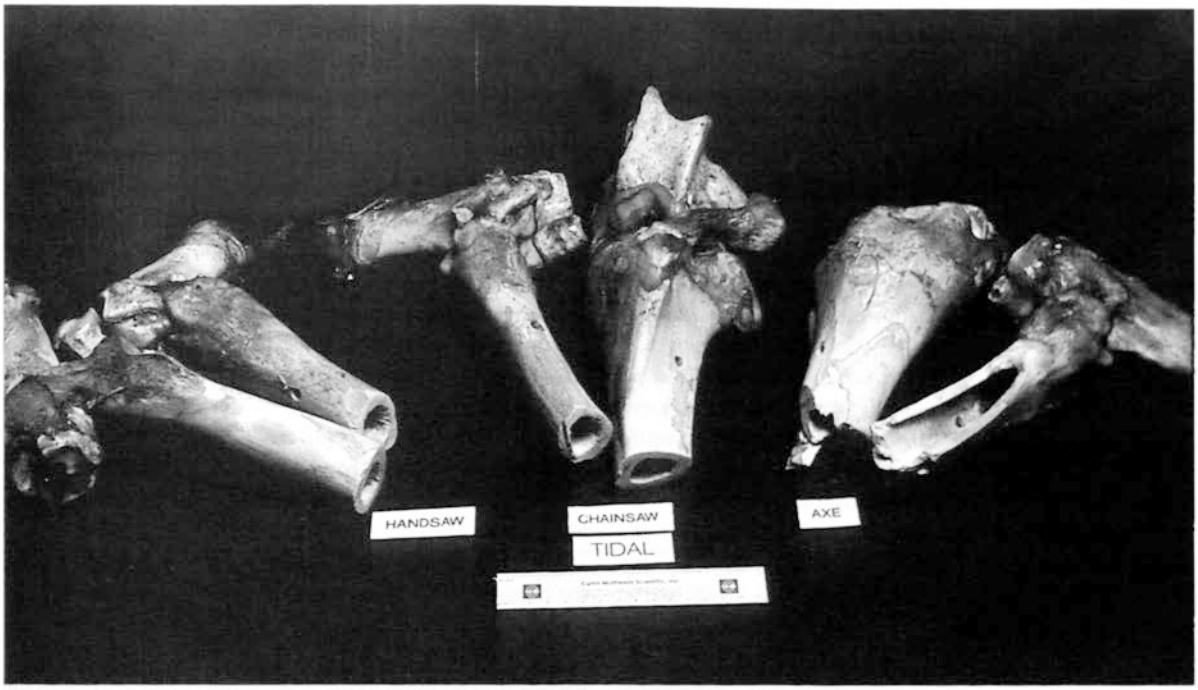

Fig. 4: Fresh, partly fleshed, articulated bones that had been exposed to a tidal environment with intermittent periods of submersion, wave activity and wind/sun drying retained residues of muscle, ligament and cartilage. The bones were still articulated and appeared oily, blotchy, and had blood stains.

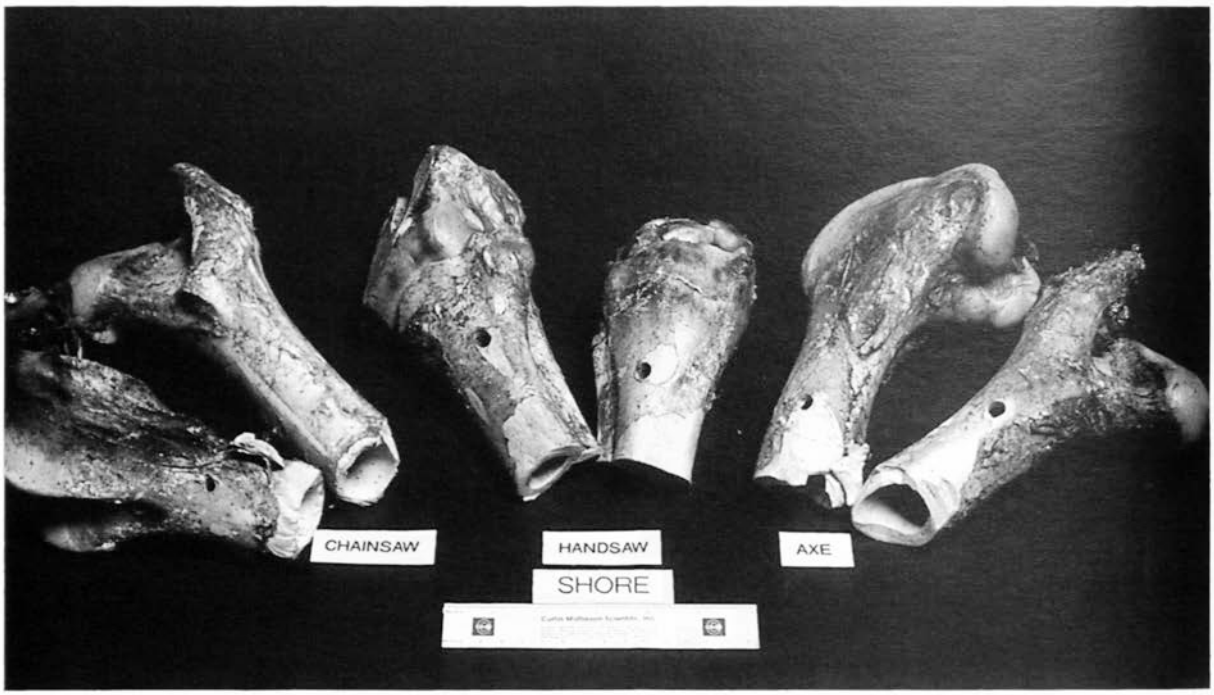

Fig. 5: Fresh, partly fleshed, articulated bones that had been exposed to a salt water beach environment retained residues of muscle, ligament and cartilage. The bones were still articulated and appeared very dry, white, with blood stains.

appear blood stained or oily, are consistent with having been exposed to the tidal zone or above the tidal area. These observable differences in such close micro-environmental zones are not surprising since Sutcliffe (1990) has described eight microclimate niches close to the water in the high arctic.

Individual carcass examination

Based on the results of the macerating and weathering experiments, we could infer possible scenarios based upon the conditions observed in the exposed cervical bones of walrus carcasses. If the vertebrae of a headless carcass are clean of muscle, ligament, cartilage, and blood staining and appear white and free of any visible organic film, it can be inferred that the carcass had been submerged in the sea for at least 19 days before washing ashore. Conversely, the presence of residues of muscle, ligament and cartilage, and if the bone appears oily, blotchy, and has blood stains suggest that either, (a) the walrus had died on the beach, and its tusks or head were removed "in situ," or, (b) the walrus died in the open water and had washed ashore shortly after death.

Carcass examinations of 1991, 1992, and 1993 showed that they could be classified into five categories (tab. 3). These categories are determined by (a) the condition of the exposed cervical vertebrae (i.e., bleached versus stained); (b) the way the tusks were harvested; and (c) if meat was harvested. The categories are defined as follows:

Category I

The skull is removed from the body by carefully disarticulating the cervical vertebra at the atlantal - occipital or the atlantal - axial junction. The exposed vertebra do not exhibit chop marks and appear white and clean of tissue or cartilage material (fig. 2)[1]. It is suggested that the carcass washed ashore in this condition because the exposed vertebral bones are free of tissue or cartilage material, and because of the similarity in appearance to the subsurface macerating bone study conducted for 19 days in the Bering sea. Advanced weathering of the vertebral bones could still be observed even after one year (fig. 3).

The inferences made of this type of carcass are that the hunter killed the walrus on an ice floe and severed the head at the kill site. This category would represent illegal take if only the head was taken but would represent legal harvest if in addition to the head, hunters had also taken the meat, flippers, and other traditionally harvested parts.

[1] These carcasses are not decomposed or disarticulated, rather they appear complete with the exception that they are headless.

Table 3: Walrus carcass examination between Cape Espenberg and Cape Wales for 1991 through 1993.

Carcass category	1991 [n = 70]	1992 [n = 147]	1993 [n = 32]
I-Disarticulated vertebrae	52 (74.3%)	104 (70.8%)	13 (40.6%)
II-Tusks pulled out	3 (4.3%)	14 (9.5%)	3 (9.4%)
III-Tusk cut out	5 (7.1%)	14 (9.5%)	5 (15.6%)
IV-Intact walrus	6 (8.6%)	3 (2%)	5 (15.6%)
V-Too decomposed	4 (5.7%)	12 (8.2%)	6 (18.8%)

Category II

The carcass is found with an intact head but the tusks have been removed with little or no evidence of mechanical damage to the tusk sockets. These carcasses might have washed ashore without tusks and no effort is made to evaluate if the tusk were pulled out or fell out during carcass drift. The ease of tusk removal might be explained on the basis that (a) decomposition of the periodontal fibers allows the tusks to fall from the socket, or (b) bone is less dense than ivory and prolonged exposure to water would cause bone to expand, whereas ivory would not.

The inference made of this type of carcass is that the walrus died of either natural or man-created causes, its body drifted for extended periods of time, and eventually washed ashore. The net result is that the tusks either fell out or were pulled out with comparative ease without breaking the alveoli. This category would represent legal harvest of the tusks by beachcombers.

Category III

The carcass is identified by severe cuts and hatchet marks to the face and maxillary structure. This type of carcass is most difficult to make inferences about because the carcass could have washed ashore intact or the walrus could have been killed "in situ." These carcasses could also represent a cryptic kill (a wounded walrus that eluded capture) in which the carcass washed ashore in a non-mutilated condition. This category would represent legal harvest of the tusks.

Table 4: Number of category I carcasses that had meat harvested (Cape Espenberg to Cape Wales).

	Meat harvested	No meat harvested
1991 (n = 52)	5 (9.6%)	44 (84.6%)
1992 (n = 104)	49 (47.1%)	55 (52.8%)
1993 (n = 13)	10 (76.9%)	3 (23.0%)

Category IV

This category is characterized by an intact carcass. This could represent either natural mortality or cryptic kill.

Category V

The carcass is in advanced decomposition indicated by the grey - white color of the skin, the caving of the abdominal cavity, autolysis of flippers, exposure of rib bone, disarticulation, etc. No inferences are made when these carcasses are encountered.

Since categories II, III, IV and V are considered legal take, category I carcasses were examined in detail to determine if any of the traditionally harvested meat such as flippers, heart, etc. had been collected. These results are listed in table 4.

The 1991 survey showed that over two-thirds of the walruses had been killed only for their tusks, in 1992 head hunting acounted for 53% of the carcasses, and in 1993 it dropped to 23.0%. Most of the male carcasses had their bacula (ooziks) removed, reinforcing the commercial aspect of head hunting. In brief, the number of walruses killed only for the ivory tusks decreased by 61% since 1991 (tab. 4).

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