

**A Taxonomy
of World Whaling:
Operations, Eras,
and Data Sources**

by

**Randall R. Reeves
and Tim D. Smith**

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A Taxonomy of World Whaling: Operations, Eras, and Data Sources

by

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Abstract

The history of whaling spans the entire globe and extends more than a millennium into the past. All species of large cetaceans have been hunted by industrial whalers for commercial purposes, and several species have also been subject to small-scale whaling for domestic use (“subsistence”). Because whaling has been conducted using an evolving variety of technologies and methods, which were themselves developed and applied in geographically diverse circumstances, it has proven difficult to obtain a systematic, overall view of the enterprise. We propose a hierarchical taxonomy to better understand the history of whaling and improve our ability to analyze its ecological importance. As the fundamental unit in this taxonomy, a whaling *operation* is defined on the basis of who was involved, what was caught, where the whaling was carried out, why whales were taken, when the whaling took place, and how it was conducted. Approximately 120 such operations are provisionally identified here, and their major features are summarized and discussed. Each of the operations is assigned to one of 14 proposed eras. An *era* is defined principally in relation to the technology or method used to kill, secure, and process whales. Consideration is also given to data sources, specifically to those sources needed to reconstruct catch histories of whale populations. Four time periods are identified for which the types of sources differ.

INTRODUCTION

World whaling has involved most of the 14 mysticete (baleen) species, many of the 28 or so medium- to large-sized odontocetes (toothed whales), and numerous geographically distinct populations of these species (at least dozens). The scale of world whaling has been global, spanning bays and gulfs, continental and island shelves, and pelagic waters. Whaling began in antiquity (more than a thousand years ago) and continues to the present. Numerous maritime societies, from all inhabited continents and many oceanic islands, have been engaged in whaling at one time or another. The technologies employed to kill, secure, and process whales have ranged from primitive and non-mechanical to technically sophisticated and industrial. The economic complexities associated with whaling have been diverse, encompassing fluctuations in production rates, product valuation, operation costs, labor characteristics, etc. Whaling ranks along with some pelagic marine fishing as the world's most spatially extensive form of exploitation of wild living resources. Therefore, understanding the history of whaling is essential to any analysis of the role of humans in modifying the marine ecosystems of the world.

Whaling is here defined as the purposeful killing of large cetaceans to obtain economically useful products. It therefore embraces both "commercial" and "subsistence" whaling (Reeves 2002). We define the large cetaceans to include all species of baleen whales (mysticetes) and the sperm whale (*Physeter macrocephalus*). In addition, we include the hunting of some of the larger beaked whales (Baird's beaked and northern bottlenose whales – *Berardius bairdii* and *Hyperoodon ampullatus*, respectively) and other medium-sized toothed whales (e.g., killer and pilot whales, belugas, and narwhals – *Orcinus orca*, *Globicephala* spp., *Delphinapterus leucas*, and *Monodon monoceros*, respectively) because it has often been ancillary to the hunting of large cetaceans and has involved similar technology and markets.

The literature on whaling is voluminous. Most of it follows disciplinary lines – biological, economic, technical, historical, anthropological/archaeological, political/regulatory, and even literary. Major works tend to be limited in scope, reflecting an author's interest in a particular nation, region, period, species, or fishery. While some studies that focus on a single region or whale population are rigorous and data-rich (e.g., Henderson 1972; Ross 1975; Bockstoce and Botkin 1983; Mitchell and Reeves 1983), overviews of the entire history of whaling are rare (e.g., Jenkins 1921; Spence 1980; Francis 1990; Ellis 1991). The monograph by Tønnessen and Johnsen (1982) (and also Tønnessen and Johnsen 1959-70) is singularly comprehensive in its coverage of "modern" whaling.

In this paper we attempt to provide a systematic overview of world whaling. Our approach has been to work toward a unified taxonomy, or classification system, of whaling activities that would help order and manage investigations of whaling history. A preliminary attempt at such a taxonomy was described in a series of papers concerned solely with the exploitation of humpback whales (*Megaptera novaeangliae*) in the North Atlantic Ocean (Smith and Reeves 2002, in press; Reeves and Smith 2002). In that case, it was possible to fit all of the relevant whaling activities into a reasonably complete and coherent framework of named "fisheries" and "subfisheries." The heuristic value of this framework was considerable when dealing with a single ocean basin and, indeed, a single species within that basin. However, in attempting to apply a similar approach on a broader scale, we found the fisheries/subfisheries concept less useful.

As an alternative to our fisheries/subfisheries approach, here we have attempted to group whaling activities or enterprises into *operations*, and to group operations, based largely but not solely on whaling methods, into *eras*. We begin by explaining how operations are defined, and by reviewing them briefly. We then describe the 14 eras which were defined after inspecting the characteristics of the operations. Finally, we review the nature of sources of whaling data. The proposed taxonomy is offered as a way of organizing and evaluating patterns, trends, and relationships among the world's whaling enterprises.

OPERATIONS AND ERAS

Operations - Mitchell and Reeves (1980) proposed what appeared to be a simple scheme for classifying various types of whaling – who, what, where, why, when, and how? Although each of these variables is multidimensional, and no single one can be used to define any particular category unambiguously, the basic scheme seems useful. As a first-order attempt to break down world whaling into manageable units, we propose the term *operation* as an alternative to *fishery* or *subfishery* (per Reeves and Smith 2002). An *operation* can be defined on the following basis:

- A. *Who* refers to the ethnic or national group involved. A whaling operation could be defined by ethnic or national origin of the people who kill the whales, by the nation on whose land a shore station is situated or under whose flag a ship operates, by who provides the capital, by who governs the waters where whaling is conducted, or by who profits from use or sale of the products. We indicate *Who* in terms of the geographic location, either the geographic region where the catches were taken or the nationality of those pursuing the operation.
- B. *What* refers to the targeted species. The capability of whaling for different species or groups of species varies with certain aspects of an operation – e.g., the technology required to catch, tow, and process the whales; the types and amounts of products that can be obtained; the importance of a species to the operation (i.e., principal or supplemental); and the seasonality and location, according to the animals' movement patterns. Often multiple species are targeted and additional species are taken opportunistically or during periods when the principal targets are unavailable. Also, there has been a typical pattern of shifting from more to less valuable or accessible species over time as targeted species become increasingly scarce or elusive. A clear example in which the targeted species help to distinguish the character of the operations is Arctic whaling, where the three Arctic species – bowhead, narwhal, and white whale (beluga) – have formed the basis for both “subsistence” and “commercial” whaling on a circumpolar scale (Vaughan 1984). Operations involving multiple target species pose special problems because the focus of the hunting process often varies across years as well as seasons, making analyses based on search effort (catch-per-unit effort) difficult. At a minimum, such analyses require a firm understanding of preference ranking (sometimes reflected in bounty payments or bonus schedules for gunners), seasonal trends in whale availability or market value, and species differences in handling and processing times. We list the species known to have been taken, distinguishing between the principal and supplemental targets for an operation.
- C. *Where* refers not only to the geographical location of the whaling, but also to whether it is local or distant from the whalers' residences. This latter question has numerous implications, not least that it largely determines whether an operation is considered shore-based, coastal, or pelagic. The variable *where* can be described at varying geographic scales, including ocean basin or region within an ocean basin, such as a whaling ground or an island area. The American open-boat pelagic whalers had the habit of naming grounds that were often visited on a predictable circuit, reflecting seasonal movements of the whales, wind and current patterns, ambient conditions for conducting whaling operations, and access to port facilities to obtain supplies (food, water, wood), recruit crew, and transship oil and baleen (Clark 1887; Townsend 1935). Such grounds have been used to delineate study areas for a number of analyses of catch history and trends in abundance (e.g., Bannister et al. 1981; Hope and Whitehead 1991). In the present context, a change in geographic location may imply the need to designate a new operation, especially for coastal whaling or a land station, but for a pelagic operation such a change may be interpreted as a mere adjustment in strategy within the same operation. As a result, the geographic scope of some pelagic operations has been vast, almost global. We summarize *Where* in terms of ocean basin (North and South Atlantic and Pacific, Indian, Arctic and Antarctic, and identify regions within those basins where shore or coastal operations occurred.
- D. *Why* refers to the products of the hunt (e.g., oil, baleen, meat, ivory) and thus the incentive(s) driving it. Market factors are crucial in determining the intensity of whaling, species

preferences, and, ultimately, the degree of stock depletion. In fact, in some population studies it has been difficult to determine whether reduced whale abundance (i.e., depletion) or market conditions (e.g., a change in product prices) were most responsible for the decline or cessation of a fishery (e.g., Best 1983; Davis et al. 1997). The traditional distinction between “commercial” and “subsistence” whaling hinges primarily on this variable (*why*), although the *how* element has also played a prominent role (Mitchell and Reeves 1980; Reeves 2002). The uses of whale products have shifted through time according to cultural preferences, availability of less expensive substitutes (e.g., spring steel replaced baleen as a garment stiffener in the early 1900s; Bockstoce 1986), and technical innovations (e.g., hydrogenation of fluid oils to produce margarine dramatically enhanced the value of baleen whale oil in the 1920s and 1930s; Tønnessen and Johnsen 1982). Nevertheless, a change in this variable alone would not necessarily be the basis for defining a new whaling operation, and we did not systematically record this characteristic.

- E. *When* refers mainly to the years or decades in which the whaling took place, although it can also refer to seasonality. The latter might determine whether or not a given operation affects a migratory whale population. The temporal history of some whaling operations is imprecise or incomplete, and in a few cases it is lacking altogether. In many instances, especially involving shore-based operations, whaling has been episodic, punctuated by years or decades of closure. For example, modern whaling factories were opened, closed, and relocated periodically in Newfoundland and Labrador (Mitchell 1974), Iceland (Sigurjónsson 1988), northwestern North America (Pike and MacAskie 1967; Reeves et al. 1985; Webb 1988), and southern Africa (Best 1994). Although we describe the temporal span of an operation simply as starting and ending years, we recognize that this can mask differences through time in the intensity of whaling (effort), catch composition (species or age/size class), catch level, and other features of interest.
- F. *How* refers to the equipment, methods, and techniques for taking and processing the whales. The distinction between shore-based and pelagic operations is relevant here, as are questions of whether powered or sailing vessels are employed, which weapons are used to capture and kill the animals, and how those are delivered (e.g., manually or mechanically) (Mitchell et al. 1986). Specific aspects of this variable can be in an almost continuous state of flux as whalers experiment and innovate, as regional availability of the targeted whale species varies, and as product, labor, and capital markets fluctuate. Best (1983), for example, described eight major improvements in vessels and gear that emerged in the American pelagic sperm whale fishery between the 1760s and 1850s, quoting Scammon’s (1874) observation that “there is hardly a fixture, or an implement, pertaining to the outfit that has not been improved upon....” While it is generally assumed that such improvements would have made whaling more profitable, they also may have allowed vessel owners to “get by” with less proficient crews, contributing to lower voyage productivity (Davis et al. 1997). Technology and practices determine to a considerable degree how efficient an operation is, efficiency being defined in terms of hunting loss, humaneness, or profitability (e.g., O’Hara et al. 1999). Hunting loss (hidden mortality, as when animals are seriously injured or killed but not secured) can significantly affect the magnitude and rate of removals and therefore must be taken into account in population analyses that are premised on the availability of complete catch histories. We recorded the mode of operation as shore, coastal or pelagic and whether mechanical power was used. We also recorded the tool used in killing and the method of delivery of that tool.

Understanding changes in these six variables, and their collinearity, is essential to defining whaling operations. The complexity of the relationships among the variables has meant that some of the decisions concerning which changes do and do not justify the designation of a “new” whaling operation are somewhat arbitrary, especially where our access to the source material has been limited.

Using the above criteria, we identified somewhat more than 120 whaling operations worldwide. For each operation, we attempted to identify the catching method (e.g., harpoon, poison dart, net), delivery method (e.g., hand-thrown, deck-mounted cannon), “platform” (shore, coastal, or pelagic), propulsion method (nonpowered or powered), cumulative secured catch level (to order of magnitude for all species, combined), start and end years, species (primary and supplemental), ocean basin, regions within ocean

basins, and relevant data sources. The approximate location of each of the shore and coastal whaling operations and the ocean basins used by the pelagic operations are shown in Figure 1. The operations are indicated by the operation sequence numbers, which are defined in the appendix table. The appendix table also lists the operations by sequence number, and includes some of their characteristics.

As with any effort of this kind, there is an inherent tension between “lumping” and “splitting.” Our bias has not been consistently in either direction. On one hand, too much lumping would gloss over a multitude of differences (in Who, What, Where, Why, When, and How), some and perhaps many of which would be meaningful and important in certain types of analyses. On the other hand, too much splitting would defeat the purpose of attempting to organize a highly fragmented, almost chaotic body of information on world whaling activities. One example can be used to illustrate this point. The spread of Norwegian mechanized shore whaling in southern Africa between 1908 and 1930 might be seen as a single integrated operation involving primarily Norwegian capital and personnel (see Best 1994). The various stations used essentially identical technology, targeted roughly the same suite of species, and served similar product markets. We nevertheless “split” these activities into different operations according to the national jurisdictions (using present-day political geography) in which the shore stations were sited (e.g., Gabon, Angola, South Africa, Mozambique). This decision is not entirely satisfactory, for it obscures the interesting and useful fact, for example, that the whaling station at Cap Lopez (present-day Gabon) and the moored floating factory at Sao Tomé (offshore of Gabon) were run during the 1950s by a Norwegian-French company (Tønnessen and Johnsen 1982:654). Similarly, a shore station in Namibia in 1913-1914 (then German Southwest Africa) was established largely by German initiative and capital combined, as usual, with Norwegian expertise (Barthelme 1993). In the 20th century, Japanese personnel and capital became closely involved in whaling with “partners” in the waters of other countries (Kasuya 2002), and again, we ascribe these joint ventures to the host nation-states as separate operations rather than to Japan as extensions of its mechanized shore or pelagic operations.

Eras – Having established a rationale and procedure for naming *operations* (which can be viewed as parallel to *species* within a biological taxonomy), we needed to devise at least one higher level of organization to capture patterns or trends in our whaling taxonomy. The concept of *era* is a familiar one to geologists and historians who frequently organize chronological data on such a basis. We used one of the Oxford English Dictionary’s definitions: “... a portion of historical time marked by the continuance throughout it of particular influences, social conditions, etc.” As demonstrated earlier in our attempt to define operations, chronology alone is not an adequate basis for defining eras. The history of whaling is marked most notably by changes in technology – e.g., transitions from: spear-and-salvage to harpoon-linefloat techniques (Lindquist 1993); stripping whales at sea and carrying the blubber home for processing, to using on-board tryworks and converting blubber to oil at sea (Ashley 1928; Whipple 1979:54); hand lance to shoulder- or darting-gun (Brown 1887); and sail to steam power (Bockstoe 1986; Webb 2001). While the timing of such developments can usually be specified or reasonably approximated, their adoption has been highly variable in both space and time. As one graphic example, Alaskan Eskimos have continued to use open skin-covered boats (umiaks) and other ancient or transitional implements and techniques to hunt bowhead whales (Stoker and Krupnik 1993), even while modern factory-ship whaling for other species in other ocean areas has arisen, peaked, and declined to relict status (Tønnessen and Johnsen 1982).

We attempted to organize the history of whaling on the basis of 14 different eras, each defined in a multivariate manner (Table 1). The temporal boundaries of most of the eras are reasonably clear (prehistoric and other “ancient” eras excepted, of course). Figure 2 shows the approximate temporal limits of the eras, with those that began in antiquity denoted by the letter A on the left and those that include one or more continuing whaling operations with right-pointing arrows. The temporal overlap of several of the eras is a significant feature of world whaling.

The spatial boundaries of eras often overlap substantially. This spatial overlap is less amenable to graphic portrayal and is, therefore, only noted here with two (of many) examples. Firstly, American Pelagic and American Shore whaling were frequently being pursued in the same bays at the same times during the 19th century. In fact, the term “bay whaling,” as used by Bannister (1986) and Dawbin (1986) in reference to near-shore whaling for right whales and humpback whales in Australia, Tasmania, and New Zealand during the 19th century, embraces activities of both shore-based whalers and pelagic whalers anchored in bays.

Secondly, Norwegian Shore and Factory-ship whaling took place alternately or concurrently in numerous areas of the Southern Hemisphere (Best 1994; Findlay 2000) and North Pacific Ocean (Ohsumi 1980; Webb 1988; Brownell et al. 2001).

A central objective in defining eras was to provide a framework for organizing the whaling operations such that a given operation could only be attributed to one era. Some of these assignments were not straightforward. As observed by Best and Ross (1986:276), whaling activities often do not fall neatly within the parameters assigned to a particular category: “Towards the end of the open-boat whaling era, and before modern whaling proper began, some ‘intermediate’ technology was adopted, including the use of small, mounted harpoon guns and some powered craft such as launches....” In fact, “experimental” whaling was particularly intensive in the North Atlantic from the late 1850s to early 1870s as American and European whalers competed to invent ways of killing and retrieving the fast-swimming rorquals (Schmitt et al. 1980; Tønnessen and Johnsen 1982). While our designations of American Shore, American Pelagic, and Transitional Steam eras were intended to accommodate much of the activity involving “intermediate” technology and “experimental” whaling, we stress that our assignments are meant to reflect central tendencies rather than clean lines of distinction.

Implicit in some of the distinctions that we have made between eras are assumptions about technology invention or transferal. We recognize that such assumptions are just that – assumptions – and that the origins of whaling in some areas and times are unknown. For example, it is uncertain whether, or to what degree, the Basque method of open-boat, hand-harpoon whaling influenced, or was influenced by, the Eskimos’ use of skin boats and hand-thrown implements to capture large whales. Numerous uncertainties surround the origins of “aboriginal” whaling operations, but it seems likely that the ability to kill and secure whales developed independently in more than one place and time. Thus, Barnes (1996) pointed out that the people of Lamalera, Indonesia, were hunting whales long before they were visited by American and European whalers in the late 18th century. The unique design of local whaling boats and sails, and the islanders’ way of leaping from a boat onto a whale’s back to secure the harpoon, clearly distinguish this warm-water “aboriginal” whaling operation that targets sperm whales, from the cold-water operation of the Eskimos that targets bowhead whales. The Indonesian operation probably has a closer affinity to that of the people of Pamilacan, Philippines, who also leaped from their boats to embed a large hook in the back of their prey, mainly Bryde’s whales (*Balaenoptera edeni/brydei*) (Dolar et al. 1994). This method dates back more than a century and has no obvious link to the activities of visiting foreign whalers.

A common theme in efforts to establish when active whaling began is the problem of “drift” whales, that is, whales that came ashore dead or dying (“stranded”) or that were discovered as floating carcasses in coastal waters (Freeman 1979; Little and Andrews 1981; McCartney 1984). In some instances, the salvage of drift whales can be interpreted as a step preceding the invention of whaling, *per se*, while in other contexts it seems clear that drift whales resulted from the active pursuit of and attempts to kill whales, i.e., they were part of the struck-but-lost component of the fishery.

SYSTEMATIC SUMMARIES OF ERAS

1. Prehistoric Unspecified – Determinations concerning the nature, or even the existence, of ancient whaling operations are generally fraught with uncertainty. Thus, while Heizer’s (1968) bibliography provides tantalizing references to whaling in Zanzibar in 1295, in “Arabia” in the 9th century, in Tierra del Fuego in the 1600s and 1700s, and in Mozambique (apparently meaning Madagascar) at some time in the ancient past, we have not been able to obtain and evaluate his sources. Even in some instances where an in-depth analysis has been conducted by an ethnographer (Lindquist 1993) or archaeologist (McCartney 1984), many aspects of the timing and nature of the origins of ancient whaling remain obscure. This era should be regarded as a holding bin for operations that date far back in time, are not known to have continued into the 19th or 20th century, and are poorly documented. We have no good basis for judging the species composition or numbers of animals that might have been removed by these operations.

2. Poison – This era is defined entirely on the basis of *how* the catching or killing was accomplished. Poison whaling consisted of two main approaches, one using aconite (from the monkshood plant) and the

other using bacillus (from necrotic tissue of a dead animal). There appear to have been multiple inventions of poison techniques at different times and in geographically distant places. Aconite poison whaling was used across the northern rim of the North Pacific (Heizer 1938; McCartney 1984; Crowell 1994), while bacillus poison whaling was practiced in Iceland and Norway (Heizer 1968). The latter involved the impoundment of whales in bays using barrier nets, then darting them with a crossbow and waiting for septicemia to debilitate or kill the animal (Jonsgård 1955). A certain amount of experimentation with “prussic [hydrocyanic] acid harpoons” took place during the 19th century, but with little reported success (Brown 1887:248-249).

Two key features of poison whaling are: (1) any species or size/age class that could be approached closely enough to dart could be targeted, and (2) the killed:secured ratio could be very high. Crowell (1994:229) supposed that fin and humpback whales were targeted by North Pacific poison whalers on the premise that these species were more likely to be available in bays during the late spring and summer months when whaling was practiced. Other authors have argued that gray whales, right whales, and possibly minke whales were targeted (Mitchell 1979). Norwegian bacillus whaling is said to have targeted minke whales primarily (Jonsgård 1955). Because no attempt was made to fasten to the whales, and it took several days for them to die (McCartney [1984:85] referred to this as the “lance-and-wait” technique), hunting loss was very high in North Pacific poison whaling. The shut-in method practiced in Norway and Iceland probably involved much less hunting loss.

It is impossible to even guess reasonably at the numbers of whales killed by the poison whalers, and if it were possible, the allocation to species would be largely speculative.

3. Net—Like poison whaling, net whaling seems to have originated independently on several different occasions in different areas. Whaling with leather nets in Kamchatka is poorly documented but was active in the 1730s-1740s (Krasheninnikov 1972) and supposedly targeted gray whales (Rice and Wolman 1971). Japanese net whaling for humpback, right, gray, Bryde’s, and probably other whale species is remarkably well documented, considering that it began in the 17th century and ended before 1900 (Omura 1984, 1986). Although some authors (see McCartney 1984:86) have suggested that net whaling was introduced to Japan by the Dutch or Portuguese, it seems clear that the technique evolved locally as a way of improving the efficiency of traditional Japanese harpoon whaling (Kasuya 2002). Whaling for humpbacks in New Zealand with steel nets was conducted from 1890 to 1910 (Dawbin 1967). We attributed the use of nets to block the escape of whales from bays in Norway and Iceland to the Poison era rather than the Net era. It also should be noted that barrier, or shut-in, nets have been used extensively to catch belugas (white whales) in the Arctic and Subarctic, but these fisheries are not included among the operations recognized here in view of the emphasis on large whales (see Introduction)

4. Arctic Aboriginal—Whaling by Eskimos centered on the bowhead whale probably began roughly 2,000 years ago (Stoker and Krupnik 1993). The basic approach involved hand-paddled skin boats launched from shore or ice, hand-thrown harpoons with rawhide lines attached to inflated sealskin floats, and hand lances. Unlike the Basque- and American-era whalers (see below), the Eskimos did not get “fast” to the whale, i.e., keep the harpoon line attached to the boat as the whale attempted to escape. Rather, they depended on the float to tire the animal and to allow them to track it so that additional harpoons-line-float arrays could be brought to bear and they could get close enough to lance the whale. A prominent feature of Eskimo whaling has been its selective incorporation of new technologies. Thus, the present-day bowhead hunt in Alaska incorporates “modern” (e.g., shoulder gun, bomb-lance, even the occasional use of aircraft for spotting) as well as traditional equipment and techniques (skin-covered boats for attacking and towing whales).

While recognizing that the original distribution of Eskimo bowhead whaling was “neither continuous nor homogeneous” (Stoker and Krupnik 1993:591), we also note that the archaeological and ethnographic records of cultural exchange and transfers of technology imply circumpolar linkages. It is generally believed that the Thule whaling culture originated in the Bering Strait region and that there was “an unbroken technologic sequence which lasted for almost two millennia” across the Arctic from Siberia eastward to Greenland (McCartney 1984:80). Separate operations have been provisionally defined on the basis of political geography. Thus, we have divided Siberian (Russian/Soviet), Alaskan (American), Canadian, and Greenlandic whaling into different operations within this era. In doing so, we recognize that

these “operations” are not monolithic or homogeneous, nor are they altogether distinct from one another historically or culturally. In the Russian Far East, both bowhead and gray whales have always been primary targets (Krupnik 1987), while in Greenland both bowhead and humpback whales were important historically (Kapel 1978; Caulfield 1997).

Few rigorous attempts have been made to quantify removals for this era. Stoker and Krupnik (1993:604) cite estimates of 790 bowheads secured in Alaska between 1910-1969, and 15-20/year between 1914 and the 1980s. Totals for the era would be at least hundreds of thousands of large whales, and probably millions of belugas and narwhals.

5. Temperate Aboriginal – We have generally followed McCartney (1984) in proposing the Temperate Aboriginal era to distinguish operations in southern Alaska, the Aleutians (including Kodiak Island), and the “Northwest Coast” of North America from those in higher latitudes. It is important to recognize that the activities of some Eskimo societies fall within this era (e.g., the Chugach Eskimos in the Gulf of Alaska), and also that there was considerable overlap, at least spatially if not also temporally, in the use of poison by kayak whalers (Poison era) and the use of standard harpoon-line-float arrays by whalers in open dugout or skin boats (this era).

Our distinction between the Arctic era and this one is not clearcut, particularly in the North Pacific basin. As observed by McCartney (1984:80) in reference to what he called “Arctic” and “Subarctic” aboriginal whaling, “to review the antiquity, spread, and patterns of whaling ... is very much a matter of interpreting fragmentary evidence.”

Principal target species appear to have been humpback and gray whales in the eastern Pacific, while the North Pacific right whale was likely a primary target of aboriginal whalers in the western Pacific.

6. Tropical Aboriginal – Relatively few operations have been identified that arose from local initiative and invention in tropical latitudes. We have provisionally included only operations in the North Atlantic (Florida) and the Indo-Pacific (Indonesia, Philippines). Operations in low latitudes that were (or in a few cases are) essentially extensions of the American 19th century open-boat fishery were considered to belong in the American Shore era rather than this era (see below). Thus, for example, the shore whaling for humpback and sperm whales in several parts of the West Indies and for humpback whales in Tonga and Equatorial Guinea are not considered part of the Tropical Aboriginal era, while those that arose independently in Indonesia and the Philippines are. We recognize that this classification is likely to arouse controversy because it is not entirely consistent with the International Whaling Commission’s terminology and management system for “aboriginal subsistence” whaling (Reeves 2002). Humpback and sperm whales are the principal species involved, except in Lamakera, Indonesia, where other rorquals are (or were) the primary targets (Barnes 1991).

7. Basque Shore – The Basque approach to shore whaling generally involved lookouts on cliffs or other high-elevation positions. Pursuit of the whales in small open boats, and attacking them with hand harpoons and lances, was the basic technique used by the Basques and their successors for many centuries, and possibly for more than a millennium. Shore whaling in Brazil was inaugurated by Basques in 1603 (Peterson 1948), and we have provisionally assigned this and ensuing Brazilian primitive shore enterprises to a single operation that extended temporally far beyond the end of the Basque Shore era. Similarly, we have provisionally assigned the brief attempt at shore whaling in the Canary Islands between 1778-1799 (Aguilar 1986) and the poorly documented shore whaling in the Cape Verde Islands from 1690-1912 (Hazevoet and Wenzel 2000) to this era, while recognizing that new information will likely lead us to reconsider and perhaps subdivide such operations, particularly the latter which may have been strongly influenced by American (“Yankee”-type) whaling (see below).

For the most part, Basque Shore whaling was confined to the North Atlantic and targeted right whales. The Brazilian operation is the only major one outside the North Atlantic. It presumably targeted southern right whales through the 1820s (Peterson 1948), after which time humpback and sperm whales may have become more prominent. Although total annual catches may not have exceeded a few hundred animals

during much of this era, its long duration means that total cumulative removals were at least in the tens, or more likely hundreds, of thousands.

8. Basque Pelagic – Basque Pelagic whaling, as defined here, took place only in the North Atlantic (including the adjacent Arctic regions). The distinction between shore and pelagic operations is not always straightforward, as the Basques (and others who adopted the Basque approach) ventured to distant regions where they set up permanent or semi-permanent shore stations for processing whales. In general, we provisionally assigned such operations to this era rather than the Basque Shore era. In addition to the Basques, the era includes whaling by British, Dutch, Danish, German, and other European nationalities. Often, an operation mounted with foreign capital depended upon Basque crew with specialized expertise (Aguilar 1986).

It is difficult to determine when this era began. However, if one includes “seasonal trips” by the Basques to southern Ireland, the English Channel, Iceland, and eventually Newfoundland and Labrador in this category, it would be some time in the 14th century (Aguilar 1986). The last Basque ship was sent to the Arctic in 1753 (Aguilar 1986). In our classification system, however, we have considered the Arctic whaling conducted from the 16th through much of the 19th century by sailing ships from Great Britain, France, Germany, the Netherlands, Denmark, and other European countries to have belonged to this era.

The frequently quoted description of British whaling in the Greenland Sea in 1671 by Frederic Martens (e.g., in Scammon 1874) defines the basic methods and techniques that characterized this era. A whale was sighted from the mother ship, oar-powered boats were launched in pursuit, and the whale was harpooned. The boats were thus made fast to, and often towed by, the whale, sometimes over considerable distances. After being killed with lances, the whale was itself towed to the mother ship and flensed alongside. Blubber was packed as cargo on-board the ship and delivered, eventually, to cookers on shore. These shore cookeries could be either in the home country or at remote sites near the whaling grounds (e.g., Spitsbergen, Labrador). Basque ships, alone among the Arctic fleet, supposedly often cooked their blubber on-board, despite the fire hazards, to avoid paying taxes for setting up their tryworks on shores claimed by European powers (Aguilar 1986; see Ellis 2002a for discussion of whether this really happened). In areas such as Labrador, however, the normal procedure was for galleons to anchor in harbors while their boats were sent away to search for and catch whales, which were then towed to shore for flensing and trying-out of the blubber (Aguilar 1986:195).

The bowhead and the North Atlantic right whale bore the brunt of whaling during this era. Sperm and humpback whales, together with narwhals, belugas, and other smaller sorts, are best regarded as supplemental targets. Aguilar (1986) estimated that 25,000-40,000 balaenids might have been taken off Newfoundland and Labrador by the Basques between 1530-1610. Other rough calculations indicate that perhaps 15,000 bowheads were taken around Svalbard between 1610-1669 and more than 85,000 between 1669-1800 (Hacquebord 1999); many tens of thousands more were taken in Davis Strait and Baffin Bay between the 1720s and early 1900s (Mitchell and Reeves 1981). Catches of balaenids over the entire era (5-plus centuries) were in the hundreds of thousands, although it is important to recognize that some of the whaling operations assigned to the Basque Shore era or the American Pelagic era contributed to these catch estimates.

9. American (“Yankee”) Shore – Whalers of this era employed the basic Basque techniques of killing and processing whales. They sighted whales from lookouts on shore, pursued them in open boats, and attacked them with harpoons and lances, at least initially. However, the era was characterized by innovation, transition, and participant diversity as described more fully below for the American Pelagic era. The essential elements of open-boat whaling as practiced during this era persisted at the Azores until 1984, Tonga until 1981, and the West Indies to the present day (see Reeves 2002). These and many of the other operations assigned to this era incorporated firearms, explosives, and mechanized vessels to some degree.

Primitive open-boat shore whaling conducted in the United States from the mid-17th century to 1924 is assigned to this era (Edwards and Rattray 1932; Sayers 1984; Reeves and Mitchell 1986, 1988; Reeves et al. 1999), as are similar operations in Bermuda from the early 17th century to 1941 (Mitchell and Reeves 1983), Australia and New Zealand from 1805-1932 (Baker 1983; Bannister 1986; Dawbin 1986) and South

Africa from 1789-1929 (Best and Ross 1986, 1989). As indicated above, some operations that have been classified recently in other contexts as “aboriginal” or artisanal (Bequia, Tonga, Azores) are here assigned to this era in view of their direct historical links to the American open-boat fishery (Clarke 1954; Reeves 2002).

Right and humpback whales were the primary targets in this era. Off western North America, gray whales were also important, as were sperm whales in those areas with deep water close to shore (e.g., the Azores, Madeira, and the West Indies). Many hundreds of thousands of whales were taken altogether.

Although this era eventually gave way during the second half of the 19th century to the Transitional Steam and Mechanized Shore eras, it did so incompletely. For example, the shore whalers on Long Island (New York) and the Outer Banks of North Carolina continued to launch their hand-powered open boats into the surf in pursuit of right whales, which they killed and processed in the old-fashioned manner, until the early 20th century (Reeves and Mitchell 1986, 1988).

10. American (“Yankee”) Pelagic – This era represents a transitional phase following the period when European whalers and Basque methods and techniques predominated. It has relatively precise start and end dates, as it began in approximately the middle of the 18th century and ended with the last American voyages in the 1920s.

The American era’s most striking aspect is rapid expansion, both in terms of geography and in terms of the size and capacity of whaling fleets. Basque Pelagic whaling was confined almost entirely to the North Atlantic Ocean, including the Arctic Atlantic, while American Pelagic whaling spanned the globe. The Basque era was dominated by European nations, while the American era was dominated by the United States. Invention of on-board tryworks (by 1762; Ashley 1928) facilitated the high-seas, long-distance voyages that typified the era (Ellis 2002b). We emphasize the transitional nature of the era and the fact that whaling equipment and practices were in an almost constant state of flux. Best (1983), for example, identified seven important innovations, in addition to on-board tryworks, including the addition of sails to whaleboats in the 1820s, the toggle harpoon in 1848, and perfection of the bomb-lance in 1852. He also identified the demand for sperm oil in the manufacture of candles as a critical motivating force (also see Ellis 2002b).

There was substantial interpenetration and integration between the American Pelagic and American Shore whaling operations, so that in a sense these could be viewed as comprising a single fishery (see Brown 1887; Clark 1887). New methods invented and adopted in one sector of the fishery, such as the shoulder gun and bomb-lance, soon found their way into the other.

We call this the American era because the United States provided most of the capital, manpower, and expertise that defined it. In 1846, near the chronological middle of the era, the world whaling fleet was estimated at approximately 1,000 sails, of which 729 were U.S.-registered (Clark 1887:192), and some of the vessels sailing under other nations’ flags had American masters and were underwritten at least partly by American capital (Stackpole 1972; Du Pasquier 1982). By the 1880s, crews, even on American ships, were extremely diverse. As Brown (1887:218) put it, “A more heterogeneous group of men has never assembled in so small a space than is always found in the forecabin of a New Bedford sperm whaler.”

Several distinctions merit particular explanation and comment. Whaling historians recognize two distinct, partly concurrent British whale fisheries: the northern fishery, meaning voyages to the Arctic Atlantic (the Spitsbergen and Davis Strait subfisheries) in pursuit of bowhead whales, and the southern (or south-seas) fishery, meaning voyages to anywhere except the Arctic in pursuit of sperm and right whales (Jenkins 1921:210). We regard the northern fishery – not only that of Great Britain, but also those of France, Germany, Denmark, the Netherlands, and other European states – as part of the Basque Pelagic era, whereas the southern fishery (again including those of Great Britain, France, Germany, Denmark, the Netherlands, and other European states) is subsumed under our American Pelagic era, as is American sailing-vessel whaling in northern regions.

The sperm whale was the focal species of the American Pelagic era as a whole, followed closely by the right whales (*Eubalaena* spp.). Bowhead, humpback, and gray whales were primary targets in particular areas and seasons. Importantly, the latter two species were hunted mainly on their winter calving/breeding grounds. Pilot whales were a significant supplemental target. Several authors have attempted to estimate total catches for large portions of this era. For example, Best (1987) estimated that American-registered vessels secured about 30,000 bowhead whales, 70,000-75,000 right whales, 14,000-18,000 humpback whales, and 2,500-3,000 gray whales between 1804-1909. Scarff (2001) adjusted Best's results for the North Pacific by incorporating information on non-American fleets and by applying a loss rate factor to account for hunting loss, producing an estimate of 26,500-37,000 North Pacific right whales killed between 1839-1909. Detailed studies by Bannister et al. (1981), Best (1983), and Hope and Whitehead (1991) provide important empirical and methodological background for global or basin-wide estimation of sperm whale catches in this era (e.g., see Whitehead 2002; Smith and Reeves 2003).

11. Transitional Steam – Steam power to propel whaling ships was introduced to the British Arctic fishery in 1857 and to the American Arctic fishery in 1866 (Brown 1887:237-238). While its initial appeal was in the way it improved navigation of ice-infested waters in high latitudes, steam was also introduced to coastal whaling operations in New England in 1880 (Clark 1887; Webb 2001). There, it facilitated the killing of fin and humpback whales in what has been described as a “shoot-and-salvage” fishery, characterized by high rates of hunting loss (Reeves et al. 2002).

The scale of catches attributed to this era is relatively small. By the time steamers were used in the Arctic, the stocks of bowheads had been greatly depleted, so only a few thousand bowheads, as well as tens of thousands of northern bottlenose whales, belugas, and narwhals were taken by the American and British steam fleets. Steam whaling vessels that cruised throughout the Gulf of Maine for fin and humpback whales from about 1880-1896 killed hundreds of fin and humpback whales (Reeves et al. 2002).

12. Norwegian (Mechanized) Shore – By the time the Norwegian inventor Svend Foyn had perfected the modern basis for mechanized catcher-boat whaling in the late 1860s, the “infrastructure” and motivation were already in place for its global proliferation. Many of the same sites where Basque Shore and American Shore whaling had taken place previously became the sites of “modern” land stations (e.g., in

Australia and New Zealand; Tønnessen and Johnsen 1982:220-221). With innovative technology that allowed the exploitation of blue and fin whales, however, opportunities arose to establish whaling stations in new areas as well, most notably on the subantarctic islands, of which South Georgia was by far the most noteworthy. Norwegian skill and enterprise were as central to this era as Basque and American contributions had been to earlier eras. We have defined operations largely on the basis of where the whaling took place (i.e., national jurisdictions), but it important to stress that Norway provided the capital and expertise for many of the shore stations, even as recently as the 1960s and early 1970s (e.g., Webb 1988). After the Second World War, the export of whale meat and blubber to Japan became a central feature of many shore-based whaling operations, particularly in South and North America and eastern Asia.

The numbers of whales killed in this era would total many hundreds of thousands, perhaps millions if one takes into account all species, including minke, killer, pilot, and other “small” whales that were supplemental to many of the operations. All commercially valuable species were hunted from shore stations. The numbers of right whales taken were relatively low because they had been depleted everywhere before this era began, and also because they were legally protected from the mid-1930s onward.

13. Factory Ship – The modern era of factory ship whaling began when the Newfoundland steamer *Sobraon* visited the South Shetland Islands in 1907 (Tønnessen and Johnsen 1982:106). The first factory ships operated essentially as floating shore stations, however, moored or anchored in bays while the catcher boats fanned out in search of prey (Best and Ross [1986] classified these as “shore-based establishments”; see Tønnessen and Johnsen [1982:503, 654] regarding the legal and biological implications). It was not until 1923 that truly pelagic factory ship whaling was underway in the Southern Ocean, and the stern slipway was not introduced until 1925/26 when the Norwegian ship *Lancing* operated off the Congo, in the Antarctic, and off Patagonia (Tønnessen and Johnsen 1982:354-55). The capability of catching and

processing with no links to shore stations gave the industry access to the final, and most profitable, whaling frontier: the Antarctic. Over the course of the 20th century, factory ship operations from at least 15 countries (not counting so-called “pirate” operations) accounted for more than a million whales worldwide (see Clapham and Baker 2002). Relatively little factory ship whaling occurred in the North Atlantic (Jonsgård 1977), and most of it in the South Atlantic was centered along the African coast or near the offshore subantarctic islands (Findlay 2000). The Antarctic and North Pacific were, by far, the most productive grounds during this whaling era, each yielding many hundreds of thousands of baleen and sperm whales. The last Soviet expedition to the Antarctic took place in 1981/82. Only Japan has continued to engage in factory ship whaling since the 1982 IWC moratorium, taking roughly 400 minke whales annually.

14. Mechanized Small-type – For this era, we relied largely upon the IWC’s formal definition of *smalltype whaling*: “... catching operations using powered vessels with mounted harpoon guns hunting exclusively for minke, [northern] bottlenose, [long-finned] pilot or killer whales” (IWC 1977:34). We used a somewhat broader interpretation so as to encompass not only the Norwegian hunt for those four species in the northern North Atlantic (clearly the intended subject of the IWC’s schedule amendment in 1976), but also the Japanese mechanized shore-based hunts for minke, short-finned pilot, killer, Baird’s beaked, and other beaked whales in the western North Pacific (Kasuya 2002). Although we recognize that there were extensive British and Norwegian fisheries for northern bottlenose whales from the 1860s to early 1900s using steam power and mounted harpoon guns, these pelagic operations were assigned to the Transitional Steam era. The Mechanized Small-type whaling in Japan (Ohsumi 1975), Iceland (Sigurjónsson 1982), and Greenland (Caulfield 1997) has been entirely shore-based, whereas Norwegian small-type whaling was and continues to be both coastal and pelagic (Christensen 1975). The total numbers of whales taken by these operations are at least in the 100,000s for the North Atlantic and the North Pacific.

DATA SOURCES

The discipline of history is founded upon sources, and an appreciation for the nature of sources is essential if we are to grasp both the limits and the possibilities for reconstructing whaling catch histories. From a biological and ecological perspective, the ultimate goal is to have definitive quantification of fishery removals from biological populations. Therefore, the *raison d’etre* for our proposed whaling taxonomy is really to provide a way of identifying, obtaining, and organizing “catch statistics” that can be used in population and ecological analyses. For fisheries generally, three periods have been identified in this regard: historical, proto-statistical (approximately 1850-1900), and statistical (since approximately 1900) (Holm et al. 2001). Sources of whaling catch data can be classified in a broadly similar manner. Thus, we suggest that whaling sources can be placed in four categories: archaeological, ethnographic/historical, production-centered, and whale-centered. These periods have approximate time boundaries (with some overlap) and can be characterized by representative source types (Table 2).

Most of the representative source types in Table 2 would be considered *primary* sources, i.e., sources of original or “raw” data. Although published lists (e.g., Starbuck 1878; Hegarty 1959; Whalemen’s Shipping List; International Whaling Statistics) and maps (e.g., Maury 1852; Townsend 1935) have often been used as primary sources for analyses (e.g., Best 1983, 1987; Mitchell and Reeves 1983; Bockstoce and Botkin 1983; Scarff 1991; Smith and Reeves, in press), it is important to recognize that they are in fact *secondary* sources derived from primary sources such as voyage logbooks or journals and customs-house or company records. In evaluating the nature, reliability, and completeness of any source, it is necessary to consider who created it and for what purpose, and why the artifact or document has survived to the present day.

The *absence* of sources for a particular fishery, area, or time period also needs to be considered. Gaps in the catch history cannot, for example, be treated as “no catch” in population analyses unless there is positive evidence for the suspension of whaling activities for the fishery, area, or time period in question. When sources of data are insufficient or lacking entirely, it is often necessary to fill gaps through interpolation or extrapolation. Failure to account for such gaps could help explain the failure of population models to “fit” observed or estimated values for current abundance or population growth rates, e.g., in the case of eastern North Pacific gray whales (IWC 1993:248-250). Even when a coarsely compiled catch history seems

sufficient to support modeling of hemisphere-wide trends, as in the case of southern right whales (IWC 2001), the need to estimate abundance and trends for individual “management units based on breeding stocks” (IWC 2001:26) creates a requirement for finer-scaled catch histories. Smith and Reeves (2002) attempted to complete the interpolations and extrapolations, and to provide the fine geographic scale, needed for a “complete” catch history of humpback whales in the North Atlantic. It remained unclear in that instance, however, whether the failure of the model to fit the data was due to problems with the catch history, estimates of current abundance and rates of increase, or the structure of the model itself (IWC 2002, in press).

Secondary sources are adequate, in some cases, for supplying the data needed to support analyses. However, in those cases where (a) there is reason to believe that the data derived from secondary sources are either incomplete or ambiguous (e.g., in regard to species taken, loss rates, etc.), (b) spatial resolution is critical, or (c) information on statistical precision is important, the need to consult primary sources may be inescapable. For example, Best (1983) provided an extremely useful summary of American Pelagic era sperm whaling based on various secondary sources, one of which (Lyman in IWC 1969) gives decadal production-derived catch estimates for sperm whales from 1800-1910. However, not only are those estimates negatively biased because of failure to account fully for non-U.S. voyages (Best 1983:43), but also there is no way to disaggregate the data so that catches can be estimated at a less than global level. Further, the secondary source material is not amenable to quantification of bias or measurement of statistical precision. In an important recent analysis of the effects of whaling on world stocks of sperm whales, Whitehead (2002: his Fig. 1) appears to have derived his global catch series for the “open-boat hunt” between 1800 and the 1920s from either IWC (1969) or Best (1983), or a combination of the two. As Whitehead acknowledges (p. 302), certain of his modeling results conflict with the evidence in primary sources (logbooks) concerning rates of decline in regional sperm whale abundance (Tillman and Breiwick 1983; Whitehead 1995). It is difficult to see how understanding of the ecological effects of whaling at the population or ecosystem level can be greatly improved without more studies of primary sources (e.g., Bannister et al. 1981; Hope and Whitehead 1991; see Smith and Reeves 2003). However difficult and time-consuming it may be to extract and analyze data from whaling voyage logbooks (which can be defined as either Production- or Individual Whale-centered sources; Table 2), the primary data embedded in Archaeological and Ethnographic/Historical sources are even more difficult to use for estimating catch series. In some instances, e.g., Prehistoric Unspecified era operations, such sources may yield nothing beyond confirmation (or supposition) that whaling took place.

Even when quantified or quantifiable data exist, the validity of the sources may be in doubt. For 20th century examples, the primary data submitted from some Soviet pelagic expeditions (Best 1988; Zemsky et al. 1995a, 1995b; Mikhalev 1997) and some Japanese (Kasuya 1999) and possibly South African (Best 1989) shore stations are known to have been falsified in one way or another. Although alternative “actual” catches have been reported for some of the falsified Soviet expeditions (e.g., Clapham and Baker 2002: their Table II), it remains unclear how the other unreliable or invalid data might be corrected.

CONCLUSIONS

In designing and developing our proposed taxonomy of world whaling, we conducted a relatively superficial review of whaling literature. We expect that, after a more thorough study, some of the operations provisionally defined here will need to be split apart or combined, and perhaps assigned to different eras. We also expect to make some revisions in the ways that we have defined the eras, although the number and nature of eras are likely to be more “stable” than those of operations. The temporal, geographical, technological, and “platform” (i.e., shore vs. pelagic) differences used to distinguish eras are sharper and less subject to interpretation (or misinterpretation) than many of the differences used to define operations.

Our main goal in this paper has been to establish the conceptual utility of our proposed taxonomy. Once this has been established, it will be necessary to refine the working set of operations and eras through a broader and more intensive review of the whaling literature and through extensive consultations with

individual historians, anthropologists, archaeologists, and biologists who have particular kinds of expertise. For example, it will be important to have the assistance of Japanese scholars in establishing the character and timing of whaling operations in East Asia, and in determining whether all such operations can appropriately be assigned to our provisional eras. Similarly, we would expect archaeologists and anthropologists whose research has centered on the development and spread of whaling in the northern North Pacific and Arctic regions to be able to improve our understanding of the Arctic Aboriginal and Temperate Aboriginal eras and of the operations that should be assigned to them.

A structured taxonomy such as the one proposed here should be useful to those interested in the history of whaling on any scale of time or space. It should also be helpful to those wishing to analyze the effects of whaling, whether at a species, population, or ecosystem level. Although it may not be possible to make reliable estimates of removals, or indeed to identify the species taken, in all whaling operations or eras, a first step must be to determine what is known, what can be known, and what is essentially unknowable. Describing what is known should be relatively easy for the operations and eras for which Individual Whale-centered data sources exist (Table 2), with the caveat that not all primary sources are reliable, as discussed above in relation to the Soviet Union, Japan, and South Africa. In many instances where the principal data sources are Production-centered, those sources have yet to be explored systematically and thoroughly. The feasibility and desirability of such exploration will depend in large part on the question or questions that one wishes to address (e.g., the degree of spatial resolution required, distance into the past deemed relevant, etc.) (e.g., see Smith and Reeves 2003).

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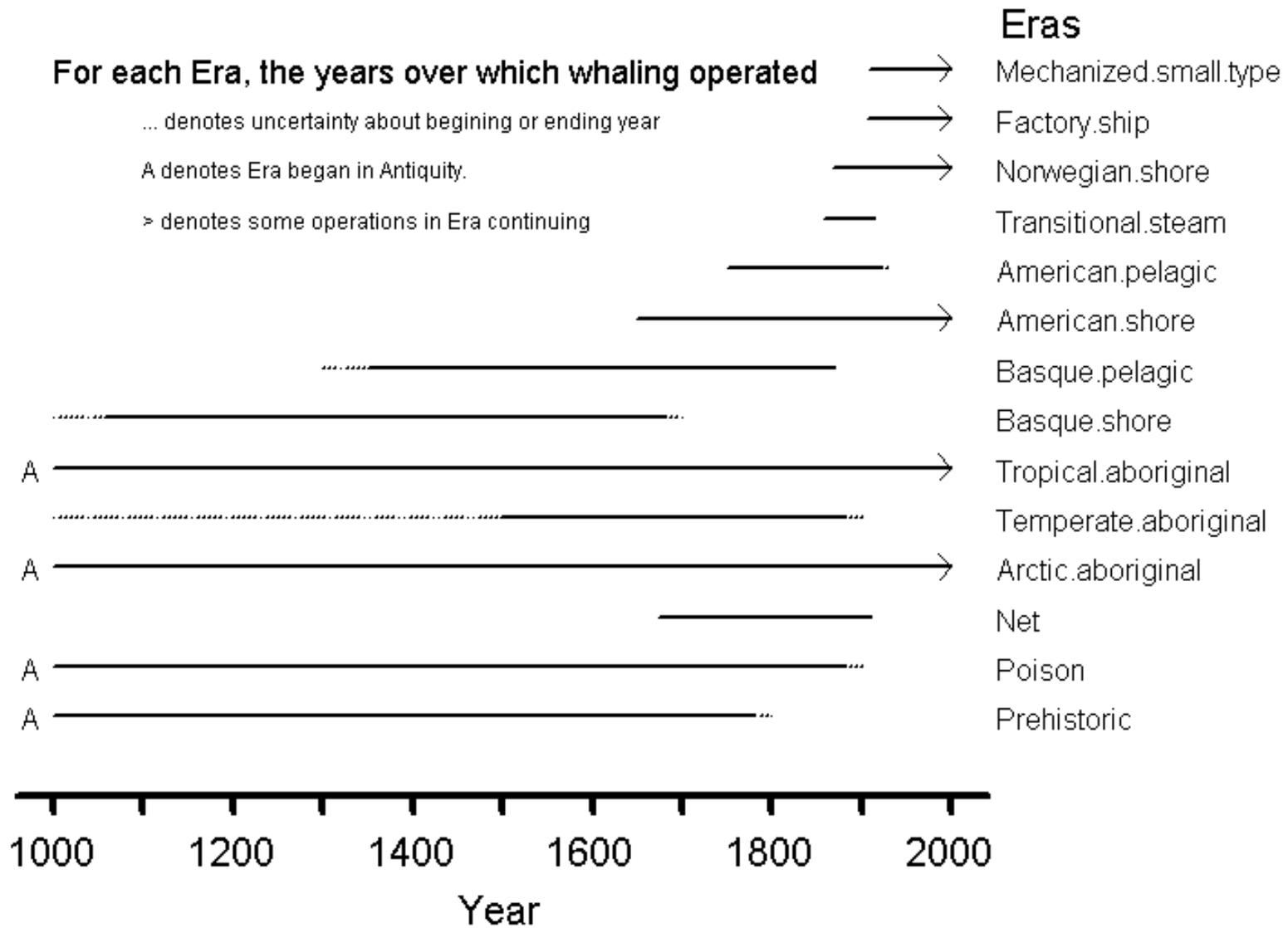
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Table 1. Fourteen whaling eras, with approximate timing, characteristic features, and spatial extent.				
Era	Start	End	Characteristic features	Spatial extent
Prehistoric Unspecified	Antiquity	<1800	Highly variable; usually not well documented by written sources and thus largely dependent upon artifacts, other archaeological evidence, sparse written narratives, oral histories, etc.	Indian Ocean, Tierra del Fuego, N Atlantic
Poison	Antiquity (<1000 A.D.)	Ca. 1900	Use of poison-tipped arrows, darts, or lances to kill, sometimes involving barrier nets as well	Norway/Iceland, Rim of N Pacific (Aleutians, Kodiak)
Net	1674	1910	Fiber, leather, or steel nets, sometimes used in conjunction with driving of animals (the many shut-in fisheries for belugas are not included here)	New Zealand, Japan, Kamchatka
Arctic Aboriginal	Antiquity (<1000 A.D.)	Ongoing	Skin boats, hand harpoons and lances grading into use of firearms and explosives in various forms, powered boats at least for towing whales to ice edge or shore for processing	Chukotka east to Greenland
Temperate Aboriginal	Antiquity (<1500 A.D.)	Early 1900s	Dugout or skin boats, mainly hand-powered; hand harpoons and lances	NW North America
Tropical Aboriginal	Antiquity	Ongoing	Open boats powered by hand or sail, hand-delivered weapons (harpoons, large hooks, blowhole plugs), shore processing	Indonesia, Philippines
Basque Shore	1059 (or earlier)	Ca. 1700	Open boats, hand- and sail-propelled, deployed from shore; harpoon-line-float; hand lance; whales towed to shore for processing	Rim of N Atlantic, some sites in eastern S America
Basque Pelagic	1300s	1870s (Arctic)	Mother-ship arrangement, dependent exclusively on hand and sail power; blubber stowed on-board and delivered to processing sites on shore; hand harpoon and lance	Rim of N Atlantic including Nearctic
American (“Yankee”) Shore	1650	Ongoing (Bequia)	Whaleboats launched from shore, hand- or sail-powered, grading into powered boats at least for towing; hand harpoons and lances grading into use of firearms and explosives in various forms	Global except Antarctic
American (“Yankee”) Pelagic	1750	1928	On-board tryworks; mother-ship operations with whaleboats, hand- and sail-powered; hand harpoons and lances grading into use of firearms and explosives in various forms	Global except Antarctic
Transitional Steam	1857	1915 (Alaska)	Introduction of steam power, use of guns and explosives; whales could be towed to shore or flensed and dismembered alongside	NE United States, South Africa, Norway, Alaska, Arctic Atlantic
Norwegian (Mechanized) Shore	1868	Ongoing (in Japan)	Powered catcher boats operating from shore stations; deck-mounted cannons; whales towed to shore processing plants	Global
Factory-ship (Norwegian-type)	1907	Ongoing (Japan in Antarctic)	Engine-powered floating factories either moored near shore or pelagic; powered catcher boats with deck-mounted cannons; eventually stern slipways on factories for on-board processing	Global
Mechanized Small-type	1908	Ongoing	Powered catcher boats; deck-mounted harpoon guns and small cannons; whales either flensed at sea or towed to shore for processing; coastal or semi-pelagic	Norway, Japan

Table 2. Four periods where the types of information available on the extent and magnitude of whaling , showing the basic features, approximate time period, and representative types of sources.

Period	Basic Features	Time Period	Representative Source Types
Archaeological	Prehistoric, artifact-based, with limited ability to make inferences from written materials (e.g., early travel narratives)	Antiquity to 18 th century	Hunting tools (e.g., harpoons); whale bones in middens or shelter structures, on beaches, or incorporated into art objects; illustrations on cave walls or scenes depicted in carvings and other art/craft forms
Ethnographic/Historical	Written or printed materials, generally based on first-hand observations by the writer	1700 to early 1900s	Descriptions in non-whaling trade newspapers, anthropological field studies, diaries or journals of whalers, personal account books
Production-centered	Records of oil, baleen (whalebone), and other whale products, usually compiled on an annual or voyage basis	1750 to early 1900s	Whaling-trade newspapers, whaling voyage logbooks and account books, customs-house records, British colonial Blue Books
Individual whale-centered	Records of numbers of whales caught and processed	1870 to present	Lists maintained by company or government officials, data sheets submitted to national or international agencies (Bureau of Whaling Statistics, International Whaling Commission)

Figure 2. Approximate time periods for the eras defined in Table 1.



Appendix to Reeves and Smith 2003. A taxonomy of world whaling: operations, eras, and data sources. Santa Cruz, CA.

Table. Details for 123 Operations according to Era, giving the Operation sequence number, location and people group involved (Who/Where), Mode (Shore, Coastal or Pelagic), Year Started and Ended, Principal and Supplemental Species, and ocean Basins. Species names and ocean basins are abbreviated (Bl=blue, Fi=Fin, Sp=sperm, Hb=humpback, Se=sei, Br=Bryde's, Gr=gray, Mi=minke, Bh=bowhead, Ri=right, and Ot=others; Ar=Arctic, Na=North Atlantic, Sa=South Atlantic, Np=North Pacific, Sp=South Pacific, Io=Indian, and An=Antarctic). Unk denotes unknown.

Era	Operation	Who/Where	Mode	Year		Species		Basins
				Start	End	Principal	Supplemental	
Prehistoric	1	Arabia	Shore	850	Unk			Io
	2	Chile	Shore	1600	1800			Sa,Sp
	3	Norway	Shore	900	1730			Na
	4	Zanzibar	Shore	Antiquity	Unk	Sp		Io
Poison	5	Iceland	Shore	1600s	Unk			Na
	6	North Pacific	Shore	Antiquity	Unk	Fi,Hb,Gr	Mi,Ri	Np
	7	Norway	Shore	1600s	1900	Mi		Na
Net	8	Japan	Shore	1674	1901	Fi,Hb,Br,Gr,Ri	Mi	Np
	9	Kamchatka	Coastal	1700s	Unk	Gr		Np
	10	New Zealand	Shore	1890	1910	Hb		Sp
Arctic Aboriginal	11	Alaskan Arctic	Shore	Antiquity	2003	Bh,Ot	Gr,Mi	Ar
	12	Canadian Arctic	Shore	Antiquity	2003	Bh,Ot		Ar
	13	Greenland Arctic	Shore	Antiquity	1920s	Hb,Bh,Ot		Ar
	14	Siberian Arctic	Shore	Antiquity	2003	Gr,Bh,Ot	Hb	Ar
Temperate Aboriginal	15	Japan	Shore	900	1880s	Fi,Hb,Gr,Ri,Ot		Np
	16	North Pacific	Shore	1500	1999	Hb,Gr	Bh,Ri	Np

Era	Operation	Who/Where	Mode	Year		Species		Basins
				Start	End	Principal	Supplemental	
Tropical Aboriginal	17	Florida	Shore	Antiquity	Unk	Ri		Na
	18	Indonesia	Shore	1600s	2003	Sp	Ot	Io
	19	Madagascar	Shore	Unk	Unk			Io
	20	Philippines	Shore	1800s	1996	Br		Sp
Basque Shore	21	Basque	Shore	1059	1688	Sp,Bh,Ri		Ar,Na
	22	Brazil	Shore	1603	1973	Sp,Hb,Ri		Sa
	23	Canary Islands (Spain)	Shore	1778	1799	Sp		Na
	24	Cape Verde Islands	Shore	1690	1912	Sp,Hb		Na
	25	Denmark/Greenland	Shore	1740s	1923	Hb,Bh		Ar,Na
	26	Mozambique	Shore	1805	Unk	Hb		Io
	27	Spain	Coastal	1789	1797	Ri		Sa
Basque Pelagic	28	Basque	Pelagic	1350	1766	Bh,Ri		Ar,Na
	29	Denmark/Norway	Pelagic	1620	1790	Bh		Ar
	30	Dutch	Pelagic	1610	1824	Bh	Sp,Ri	Ar,Na
	31	French	Pelagic	1610	1868	Bh	Ri,Ot	Ar,Na
	32	Germany	Pelagic	1640	1801	Bh		Ar
	33	Great Britain	Pelagic	1570	1911	Bh,Ri		Ar,Na
American Shore	34	Australia	Shore	1805	1932	Sp,Hb,Ri		Sp,Io
	35	Azores	Shore	1851	1984	Sp		Na
	36	Barbados	Shore	1868	1913	Hb		Na
	37	Bermuda	Shore	1607	1941	Sp,Hb		Na
	38	Canada	Shore	1775	1850	Hb,Ri		Na

Era	Operation	Who/Where	Mode	Year		Species		Basins
				Start	End	Principal	Supplemental	
American Shore (cont.)	39	Chile	Shore	1870s	1908	Sp,Hb,Ri		Sp
	40	Equatorial Guinea	Shore	1850	1975	Hb		Sa
	41	Hawaii	Shore	1840s	Unk	Sp,Hb		Np
	42	Madeira	Shore	1941	1981	Sp	Fi,Hb,Ri	Na
	43	Mexico	Shore	1850s	1885	Gr		Np
	44	New Hebrides	Shore	1800s	Unk	Hb		Sp
	45	New Zealand	Shore	1825	1933	Hb,Ri	Sp	Sp
	46	Norfolk Island	Shore	1858	1910	Hb		Sp
	47	Russia	Shore	1850	1873	Bh,Ri	Gr	Ar,Np
	48	South Africa	Shore	1789	1929	Ri	Hb	Sa,lo
	49	Tonga	Shore	1890s	1981	Hb		Sp
	50	Trinidad	Shore	1826	1865	Hb		Na
	51	U.S. Arctic	Shore	1884	1914	Bh		Ar
	52	U.S. East Coast	Shore	1650	1924	Hb,Gr,Ri	Ot	Na
53	U.S. West Coast	Shore	1854	Unk	Hb,Gr		Np	
54	West Indies	Shore	1876	2003	Sp,Hb	Ot	Na	
American Pelagic	55	Australia	Pelagic	1828	1896	Sp,Hb,Ri		Sp,lo
	56	Azores	Pelagic	1875	1900	Sp		Na
	57	Bermuda	Pelagic	1786	Unk	Sp,Ri		Na,Sa
	58	Canada	Pelagic	1804	1893	Sp,Hb,Ri	Bl,Fi	Na,Sa,Sp
	59	Denmark	Pelagic	1800s	Unk	Ri		Sp
	60	Dutch	Pelagic	1840	1860	Gr		Sa,Np,Sp
	61	French	Pelagic	1784	1868	Sp,Ri	Gr	Sa,Np,Sp,lo
	62	Germany	Pelagic	1800s	Unk	Gr,Ri		Np,Sp

Era	Operation	Who/Where	Mode	Year		Species		Basins
				Start	End	Principal	Supplemental	
American Pelagic (cont.)	63	Great Britain	Pelagic	1775	1850s	Sp,Ri	Ot	Na,Sa,Np,Sp,lo
	64	Hawaii	Pelagic	1832	1878	Sp,Bh,Ri		Ar,Np
	65	New Zealand	Pelagic	1800s	Unk	Sp,Ri		Sp
	66	Portugal	Pelagic	1774	1890s	Sp,Ri		Sp
	67	Russia	Pelagic	1852	1860	Gr,Bh,Ri		Np
	68	South Africa	Pelagic	1816	1846	Ri		Sa,lo
	69	Tahiti	Pelagic	1800s	Unk	Sp		Np,Sp
	70	United States	Pelagic	1730	1925	Sp,Hb,Gr,Bh,Ri	Ot	Ar,Na,Sa,Np,Sp,lo
Transitional Steam	71	Great Britain	Pelagic	1859	1910	Bh,Ot	Ot	Ar
	72	Great Britain	Pelagic	1877	1896	Ot		Ar,Na
	73	Norway	Coastal	1882	1930	Ot		Na
	74	United States	Pelagic	1878	1910	Bh	Gr	Ar
	75	United States	Coastal	1880	1896	Fi,Hb		Na
Norwegian Shore	76	Angola	Shore	1910	1928	Bl,Fi,Sp,Hb,Se,Br	Ri	Sa
	77	Argentina	Shore	1904	1960	Bl,Fi,Sp,Hb,Se,Ri		Sa
	78	Australia	Shore	1912	1978	Sp,Hb	Bl	Sp,lo
	79	Brazil	Shore	1910	1986	Fi,Sp,Hb,Se,Br,Mi	Bl	Na,Sa
	80	Canada	Shore	1898	1971	Bl,Fi,Sp,Hb,Se	Ot	Na,Np
	81	Chile	Shore	1900	1981	Bl,Fi,Sp,Hb,Se,Br	Ri	Sa,Sp
	82	China	Shore	1953	1981	Fi,Hb,Br,Mi	Gr	Np
	83	Denmark/Greenland	Shore	1924	2003	Fi,Hb,Mi		Na
	84	Faroes	Shore	1894	1987	Bl,Fi,Sp,Hb,Se	Mi,Ri,Ot	Na

Era	Operation	Who/Where	Mode	Year		Species		Basins
				Start	End	Principal	Supplemental	
Norwegian Shore (cont.)	85	Gabon (Congo)	Shore	1922	1959	Hb		Sa
	86	Germany	Shore	1883	1914	Bl,Hb		Na,Sa
	87	Great Britain	Shore	1903	1951	Bl,Fi,Sp,Hb,Se,Ri	Ot	Na
	88	Iceland	Shore	1883	1989	Bl,Fi,Sp,Hb,Se	Ri	Na
	89	Japan	Shore	1896	1985	Bl,Fi,Sp,Hb,Se,Br,Gr		Np
	90	Mozambique	Shore	1912	1923	Hb	Bl,Fi,Sp,Br	Io
	91	Namibia (SW Africa)	Shore	1912	1930	Bl,Fi,Hb	Sp,Se	Sa
	92	New Zealand	Shore	1910	1964	Hb	Sp,Br	Sp
	93	Norfolk Island	Shore	1948	1962	Hb		Sp
	94	Norway	Shore	1864	1971	Bl,Fi,Sp,Hb,Se	Ri,Ot	Na,Sa,Io
	95	Peru	Shore	1952	1980s	Bl,Fi,Sp,Se,Br		Sp
	96	Philippines	Shore	1983	1985	Br		Np
	97	Portugal	Shore	1925	1951	Fi	Bl,Sp	Na
	98	Russia	Shore	1883	1912	Bl,Fi,Hb,Se,Gr		Ar,Na,Np
99	South Africa	Shore	1908	1976	Bl,Fi,Sp,Hb,Se,Br,Ri	Mi	Sa,Io	
100	Soviet Union	Shore	1932	1992	Bl,Fi,Sp,Hb,Se,Gr,Bh,Ri		Ar,Np	
101	Spain	Shore	1921	1985	Fi,Sp,Se		Na	
102	United States	Shore	1911	1972	Bl,Fi,Sp,Hb,Ri	Se,Ot	Np	
Factory Ship	103	Chile	Pelagic	1906	1914	Bl,Hb,Ri		Sp,An
	104	Denmark	Pelagic	1930	1932			An
	105	Dutch	Pelagic	1946	1964	Bl,Fi,Sp,Hb	Se	An

Era	Operation	Who/Where	Mode	Year		Species		Basins
				Start	End	Principal	Supplemental	
Factory Ship (cont.)	106	French	Pelagic	1949	1959	Hb	Sp,Se,Br	Sa
	107	Germany	Pelagic	1936	1939	Bl,Fi,Sp,Hb	Se,Ri	Np,Sp,Io,An
	108	Great Britain	Pelagic	1919	1963	Bl,Fi,Sp,Hb,Se		An
	109	Japan	Pelagic	1934	2003	Bl,Fi,Sp,Hb,Se,Br,Mi		Np,Sp,Io,An
	110	Norway	Pelagic	1907	1968	Bl,Fi,Sp,Hb,Se,Gr,Ri		Na,Sa,Np,Sp,Io,An
	111	Onassis	Pelagic	1950	1956	Bl,Fi,Sp,Hb	Se,Ri	Sp,An
	112	Pirates	Pelagic	1968	1979	Bl,Fi,Sp	Hb,Ri	Na,Sa
	113	Portugal	Pelagic	1925	1925	Fi,Sp	Bl	Na
	114	Russia	Pelagic	1903	1904			Np
	115	South Africa	Pelagic	1909	1957	Bl,Fi,Sp		An
	116	South Korea	Coastal	1946	1986	Fi,Mi	Se,Gr	Np
	117	Soviet Union	Pelagic	1932	1985	Bl,Fi,Sp,Hb,Se,Br,Gr,Mi,Ri		Np,An
118	Spain	Pelagic	1924	1934	Fi,Sp		Na	
119	Taiwan	Coastal	1955	1979	Hb,Br		Np	
120	United States	Pelagic	1921	1941	Bl,Fi,Sp,Hb,Gr		Np,Sp,An	
Mechanized Small-Type	121	Iceland	Shore	1914	1985	Mi		Na
	122	Japan	Shore	1948	2003	Mi,Ot		Np
	123	Norway	Pelagic	1920s	2003	Mi,Ot	Ot	Na

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