HUMPBACK WHALE (*Megaptera novaeangliae*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

During summer there are at least five geographically distinct humpback whale feeding aggregations occurring between latitudes 42°N and 78°N. These feeding areas are (with approximate number of humpback whales in parentheses): Gulf of Maine (400); Gulf of St. Lawrence (200); Newfoundland and Labrador (2,500); western Greenland (350); and the Iceland-Denmark strait (up to 2,000) (Katona and Beard 1990). The western North Atlantic stock is considered to be include all humpback whales from these five feeding areas.

Humpback whales from all of the western North Atlantic feeding areas migrate to the Caribbean in winter, where courtship, breeding, and calving occur. The majority (85%) are found on Silver and Navidad Banks off the north coast of the Dominican Republic. The remainder are scattered in Samana Bay (Dominican Republic), along the northwest coast of Puerto Rico, through the Virgin Islands, and along the eastern Antilles chain south to Venezuela (Katona and Beard 1990). Courtship groups on the wintering ground contain whales from different feeding aggregations, so that humpbacks from the western North Atlantic probably interbreed (Katona *et al*. 1994). Apparently, not all humpback whales from this stock winter in the West Indies, as there are winter reports from Bermuda, the Gulf of Maine, Newfoundland, Greenland, and Norway (Katona *et al*. 1994)

Clapham *et al*. (1993) reported a high degree of individual site fidelity, both within and between years, from a long-term study of identified humpback whales in waters off Cape Cod. Some reproductive parameters which have been estimated for humpback whales from this area are discussed below.

An increased number of sightings of young humpback whales in the vicinity of the Chesapeake and Delaware bays occurred in 1992 (Swingle *et al*. 1993). Wiley *et al*. (1995) reported 38 humpback whale strandings which occurred during 1985-1992 in the U.S. mid-Atlantic and southeastern states. Humpback whale strandings increased, particularly along the Virginia and North Carolina coasts, and most stranded animals were sexually immature. They concluded that these areas are becoming an increasingly important habitat for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area. There have also been a number of wintertime humpback sightings in coastal waters of the southeastern U.S. (NMFS unpublished data; New England Aquarium unpublished data; Florida DEP, unpublished data). Whether the increased sightings represent a distributional change, or are simply due to an increase in sighting effort, is presently unknown.

Feeding is the principal activity of humpback whales in New England waters, and their distribution in New England waters has been largely correlated to prey species and abundance, although behavior and bottom topography are factors in foraging strategy (Payne *et al*. 1986, 1990). Humpback whales are believed to be largely piscivorus when in these waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes dubius*), and other small fishes. Commercial depletion of herring and mackerel led to an increase in sand lance in the southwestern Gulf of Maine in the mid 1970s with a concurrent decrease in humpback whale abundance in the northern Gulf of Maine. Humpback whales were densest over the sandy shoals in the southwestern Gulf of Maine favored by the sand lance during much of the late 1970s and early 1980s, and humpback distribution appeared to have shifted to this area (Payne *et al*. 1986). An apparent reversal began in the mid 1980s, and herring and mackerel increased as sand lance again decreased (Fogarty *et al*. 1991). Humpback whale abundance in the northern Gulf of Maine increased dramatically during 1992-93 , along with a major influx of herring (College of the Atlantic, pers. comm.). Humpback whales were few in nearshore Massachusetts waters in the 1992-93 summer seasons, and more abundant in the offshore waters of Cultivator Shoal and Northeast Peak on Georges Bank, and Jeffreys Ledge — more traditional areas of herring occurrence (Center for Coastal Studies, pers. comm.). In 1996, small sand lance returned to the Stellwagen Bank area, and humpback whales were once again relatively abundant. However, unlike previous cycles, where an increase in sand lance corresponded to a decrease in herring, herring remained relatively abundant in the northern Gulf of Maine, and humpbacks correspondingly continued to occupy this portion of the habitat (unpublished data, Center for Coastal Studies and College of the Atlantic). Humpback whales, their habitat, and their prey are also linked by a diverse repertoire of feeding behaviors (Hain *et al*. 1982; Hain *et al*. 1995).

A major research initiative was begun in early 1992 — the Years of the North Atlantic Humpback (YONAH) Project (Allen *et al*. 1993). This project is a large-scale, intensive, ocean-wide study of humpback whales throughout their entire

North Atlantic range conducted over three years. Photographs for individual identification and biopsy samples for genetic analyses were collected from both summer feeding areas in the northeast and breeding grounds in the West Indies. Data are now being analyzed to determine the current population status and genetic relationships of humpback whales throughout their range.

POPULATION SIZE

Two abundance estimates are available for humpback whales, one is of animals in the northeast U.S. Atlantic and the other of all humpbacks west of Iceland (Table 1).

A population size of 294 humpback whales (CV=0.45) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CeTAP 1982). The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate includes a dive-time scale-up correction of 3.6 but was not corrected for g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

Katona *et al*. (1994), using photo-identification techniques and Bailey's modification of the Chapman capture-recapture method, estimated that the total humpback whale population in the North Atlantic Ocean west of Iceland during the years 1979-1990 averaged 5,543 humpback whales (CV = 0.16; Table 1).

The best available current abundance estimate for the western North Atlantic humpback whale is 5,543 (CV=0.16) as estimated in Katona *et al.* (1994) because it is the most current and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for Western North Atlantic humpback whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring and summer 1978-82	Cape Hatteras, NC to Nova Scotia	294	0.45
1979-90	N. Atlantic ocean west of Iceland	5,543	0.16

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for western North Atlantic humpback whales is 5,543 (CV=0.16). The minimum population estimate for this stock is 4,848 humpback whales (CV=0.16).

Current Population Trend

There are insufficient data with which to determine trends.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Katona and Beard (1990) suggest an annual rate of increase of 9%; however, the lower 95% confidence level was less than zero. Other life history parameters that could be used to estimate net productivity include the following: mean birth rate for identified humpbacks in the southwestern Gulf of Maine during 1979-87 was 8% (CV = 0.25), with no significant inter-annual differences; calving interval was 2.35 years (CV = 0.30); and the average age at attainment of sexual maturity for both males and females was five years (Clapham and Mayo 1990; Clapham 1992). A recent report where interbirth intervals were used estimated population growth rate at 6.5% (SE=0.012) (Barlow and Clapham 1997). These findings will be evaluated for use in future stock assessment reports.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (Wade and Angliss 1997). The minimum population size is 4,848 (CV=0.16). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because this stock is listed as an endangered species under the Endangered Species Act (ESA). PBR for the western North Atlantic humpback whale stock is 9.7 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1991 through 1995, the total estimated human-caused mortality and serious injury to humpback whales is estimated as 5.5 per year. This is derived from three components: 1) the observed fishery, 0.7; 2) additional fishery interaction records, 3.4; and 3) vessel collision records, 1.4. For the reasons described below, the additional records (from other than the observed fishery) cannot provide a quantitative estimate, but suggest that a number of additional serious injuries and mortalities do occur.

Background

As with right whales, human impacts (vessel collisions and entanglements) are factors slowing recovery of the population. There is an average of four to six entanglements of humpback whales a year in waters of the southern Gulf of Maine and additional reports of vessel-collision scars (unpublished data, Center for Coastal Studies). In addition, of 20 dead humpback whales, principally in the mid-Atlantic, where decomposition state did not preclude examination for human impacts, Wiley *et al*. (1995) reported that six (30%) had major injuries possibly attributable to ship strikes, and five (25%) had injuries consistent with possible entanglement in fishing gear. One whale displayed scars that may have been caused by both ship strike and entanglement. Thus, 60% of the whale carcasses which were suitable for examination showed signs that anthropogenic factors may have contributed to, or been responsible for, their death. Wiley *et al*. (1995) further reported that all stranded animals were sexually immature, suggesting a winter or migratory segregation and/or that juvenile animals are more susceptible to human impacts. Humpback whale entanglements also occur in relatively high numbers in Canadian waters. Reports of collisions with fixed fishing gear set for groundfish around Newfoundland averaged 365 annually from 1979 to 1987 (range 174-813). An average of 50 humpback whale entanglements (range 26-66) were reported annually between 1979 and 1988, and 12 of 66 humpback whales that were entangled in 1988 died (Lien *et al*. 1988). Volgenau *et al*. (1995) also summarized existing data and concluded that in Newfoundland and Labrador, cod traps caused the most entanglements and entanglement mortalities (21%) of humpbacks between 1979 and 1992. They also reported that gillnets are the gear that has been the primary cause of entanglements and entanglement mortalities (20%) of humpbacks in the Gulf of Maine between 1975 and 1990.

Fishery-Related Serious Injuries and Mortalities

The total average annual estimated fishery-related mortality and serious injury in fisheries monitored by NMFS between 1991-1995 was 0.7 humpback whale (CV = 0.27) (Table 2). Two mortalities were observed in the pelagic drift gillnet fishery since 1989. In winter 1993, a juvenile humpback was observed entangled dead in a pelagic drift gillnet along the 200 m isobath northeast of Cape Hatteras; in early summer 1995, a humpback was entangled and dead in a pelagic drift gillnet on southwestern Georges Bank.

Additional reports of mortality and serious injury relevant to comparison to PBR, as well as description of total human impacts, are contained in records maintained by the Northeast Regional Office/NMFS. A number of these records (11 entanglements involving lobster gear) from the 1990-94 period were used in the 1997 List of Fisheries classification (62 FR 33, Jan. 2, 1997). For this report, the records of stranded or floating (dead, injured, and/or entangled) humpbacks for the period 1991 to 1995 were reviewed. In more than half the records, either advanced decomposition of beached animals, no evidence of human impacts, or reports of "animal freed itself" or "was disentangled" eliminated the records from further consideration. Of the remaining records, there were three mortalities were fishery interaction was possible or probable, and

14 records where serious injury attributable to fishery interaction was possible or probable—for a total of 17 records in the five-year period (Table 3). While these records are not statistically quantifiable in the same way as the observed fishery records, they do, however, suggest entanglements in addition to those reported by fishery observers.

If Canadian entanglements, the 17 records reported above, and the possible mid-Atlantic entanglement records reported above are considered, along with injuries that may lead to reduced viability and/or eventual mortality of formerly entangled whales, the total number of mortalities and serious injuries to humpback whales will be more than the 0.7 humpbacks per year estimated from observed fisheries alone.

Fishery Information

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year, several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras. By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in either the pelagic longline, pelagic pair trawl, or other fisheries monitored by NMFS.

The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, and 1995 were 233, 243, and 232, 197, and 164 respectively. Fifty-nine vessels participated in this fishery between 1989 and 1993. In 1994 there were 12, and in 1995 there were 11 vessels in the fishery (Table 2). Observer coverage, percent of sets observed, was 20% in 1991, to 40% in 1992, 42% in 1993, 87% in 1994, and 99% in 1995. The greatest concentrations of effort were located along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated catch rates, by strata (Northridge 1996). Estimates of the total annual bycatch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack, in prep.). Estimated annual mortality (CV in parentheses), extrapolated from fishery observer data, was 0.7 (1.00) in 1991, 0.4 (1.00) in 1992, 1.5 in 1993 (0.34), 0 in 1994 (0), and 1.0 in 1995 (0). The total average annual estimated fishery-related mortality and serious injury in fisheries monitored by NMFS between 1991-1995 was 0.7 humpback whale (CV = 0.27) (Table 2).

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and U.S. Mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994 (including 11 serious injuries or mortalities of humpback whales).

Table 2. Summary of the incidental mortality of the humpback whale (*Megaptera novaeangliae*), by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	91-95	1994=12 1995=11	Obs. Data Logbook	.20, .40, .42, .87, .99	0, 0, 1, 0, 1	0.7, 0.4, 1.5, 0, 1.0[5]	1.00, 1.00, 0.34, 0, 0	0.7 (.27)
TOTAL								0.7 (.27)

[1] 1994 and 1995 shown, other years not available on an annual basis.

[2] Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).

[3] The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.

[4] For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period (Bisack, in prep).

[5] One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.08 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.01 animals

Table 3. Summarized records of mortality and serious injury likely to result in mortality, North Atlantic humpback whales, 1991-1995. This listing includes only records related to U.S. commercial fisheries and/or U.S. waters. Cause of mortality or injury assigned based on records maintained by NMFS/NER.

Date	Report type	Assigned cause	Photo ID, Sex/age	Location	Notes
5/31/91	mortality	fishery interaction	"Silver" adult female length = 13.9 m	40° 39' 73° 05'	line and/or cable from unknown gear; seen entangled several days before beaching, fresh scars, line through mouth, scars around pectorals, marks around mouth and jaw with exposed bone
8/1/91	serious injury	fishery interaction	"Stalactite" sex unknown length (est.) = 12 m	42° 51' 70° 45'	gillnet and assorted lobster, tuna gear and grappling hook; trailing 50' netting, net around mouth and tail; emaciated and tired; disentangled 8/11/91; in poor condition
8/28/91	serious injury	fishery interaction	"Manta" adult female born 1984	43° 15' 70° 03'	entangled around flukes with line, moving slowly, tired, gasping, hanging flesh between flukes, appears life threatening

Date	Report type	Assigned cause	Photo ID, Sex/age	Location	Notes
2/14/92	mortality	vessel collision	8.6 m female	Chesapeake Bay mouth	floater; propeller wounds, fractured mandible and eye socket,; injuries may not have been immediately fatal, some signs of healing present; animal very thin; boat collision
4/17/92	mortality	vessel collision	8.9 m female	National Seashore, Assateague, Maryland	possible boat strike, blunt trauma to right side, advanced decomposition
5/13/92	serious injury	fishery interaction	“Strait” sex unknown, juvenile born 1991	42° 26' 70° 21'	gillnet line through mouth and around flipper, mouth lines anchored to bottom, animal worn out and in peril, open wounds on tail, disentangled
8/3/92	serious injury	fishery interaction	unknown	42° 16' 70° 05'	orange mesh netting and line wrapped over head and back with about 15-20' trailing, animal moving slowly and not fluking
8/9/92	serious injury	fishery interaction	length (est.) = 13 m	44° 16' 68° 03'	monofilament net and poly lines across back and one flipper; gear may be trailing but not seen; bleeding, abrasions, labored breathing
9/17/92	serious injury	fishery interaction	length (est.) = 13 m	43° 09' 70° 09'	1/2", 3-strand grey poly line w poly ball; poly ball removed; breathing labored
9/26/92	serious injury	fishery interaction	length (est.) = 8 - 10 m	41° 00' 71° 50'	monofilament gillnet w/ 5/8" poly lines; mesh visible; gear wrapped around head, flippers, and bunched at tail region; labored breathing and trumpeting
10/8/92	serious injury	fishery interaction	estimated to be adult size	41° 08' 69° 11'	lobster or longline gear w/large orange buoy; whale entangled at dorsal fin; breathing labored
10/9/92	mortality	vessel collision	8.7 m female	Metompkin Island, Acomac, Virginia	fresh dead; external bruising and hemorrhage; boat collision
10/22/92	mortality	fishery interaction	unknown	36° 46' 75° 57'	line entanglement scars and cuts on leading edge of fluke and around caudal peduncle

Date	Report type	Assigned cause	Photo ID, Sex/age	Location	Notes
4/22/93	serious injury	fishery interaction	age and sex unknown	42° 01' 70° 06'	line around tail region and flukes, whale thin; unknown if gear trailing; same whale disentangled on 4/24/93??; thin and weak; healing around line
5/5/93	serious injury	fishery interaction	age estimated 2-3 y.o.	42° 26' 70° 27'	buoy warp wrapped around base of flipper; anchored and very fatigued; whale freed itself; unknown whether carrying gear
7/26/93	serious injury	fishery interaction	unknown	44° 00' 67° 38'	entangled; line wrapped around head and behind blowhole
8/8/93	serious injury	fishery interaction	unknown	44° 17' 68° 00'	net & buoys on head, dorsal fin, flippers; trailing gear; stressed behavior; cuts and blood reported, netting was removed, line remained on tail
10/7/93	serious injury	vessel collision	unknown	Atlantic City, New Jersey	boat collision with 33 ‘ sport fishing vessel; extent of injuries undetermined
7/14/94	serious injury	fishery interaction	unknown	43° 23' 68° 59'	CG helicopter crew reported animal with gillnet wrapped around head and swimming at surface
2/28/95	mortality	fishery interaction	unknown	35° 17' 75° 31'	stranded dead with gear wrapped around tail region
5/26/95	serious injury	fishery interaction	length (est.) = 10 m	41° 16' 69° 20'	net and monofilament around tail region; whale anchored; mesh visible and gear trailing
6/4/95	mortality	vessel collision	8.9 m male	Virginia Beach, Virginia	floater off inlet; lacerations along peduncle, probable ship strike
4/2/96	mortality	vessel collision	7.2 m female	Cape Story, Virginia Beach, Virginia	fresh dead; fractured left mandible; emaciated
5/9/96	mortality	vessel collision	6.7 m female	mouth of Delaware Bay	propeller cuts behind blowhole, moderate decomposition; ship strike

Table notes:

1.The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was reported beached, entangled, or injured. 2.

National guidelines for determining what constitutes a serious injury have not been established. Interim criteria as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
3. Assigned cause based on best judgement of available data. Additional information may result in revisions.
4. Entanglements of juvenile whales may become more serious as whale grows.
5. There is no overlap between tables 2 and 3 (the two records from the observed fishery are not included in Table 3).

Other Mortality

Between November 1987 and January 1988, 14 humpback whales died after consuming Atlantic mackerel containing a dinoflagellate saxitoxin. The whales subsequently stranded in the vicinity of Cape Cod Bay and Nantucket sound. During the first six months of 1990, seven dead juvenile (7.6 to 9.1 m long) humpback whales stranded between North Carolina and New Jersey. The significance of these strandings is unknown, but is a cause for some concern.

As reported by Wiley *et al*. (1995) injuries possibly attributable to ship strikes are more common and perhaps more serious than those from entanglements. In the NER/NMFS records examined, several contained notes about wounds or probable/possible vessel collision. While researchers often tend to attribute strikes to large vessels, the record of 7 October 1993 off Atlantic City, NJ, reports a collision (and subsequent injury) with a 33 ft sport-fishing vessel. To better assess human impacts (both vessel collision and net entanglement), and considering the number of decomposed and incompletely or unexamined animals in the records, there needs to be greater emphasis on the timely recovery of carcasses and complete necropsies.

While entangled animals are often released, on the other hand, some dead or injured animals likely go unobserved and unreported. The literature and review of records described above suggest that there are significant human impacts beyond those in the fishery observer data. Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent 'lost data', some of which may relate to human impacts. For these reasons, the human impacts listed in this report must be considered a minimum estimate.

STATUS OF STOCK

The size of this stock is considered to be low relative to OSP in the U.S. Atlantic EEZ, and this species is listed as endangered under the ESA. A Recovery Plan has been published and is in effect (NMFS 1991). There are insufficient data to determine the population trends for humpback whales. The annual rate of population increase was estimated at 9% (Katona and Beard 1990), but the lower 95% confidence level was less than zero. The total level of human-caused mortality and serious injury is unknown, but current data indicate that it is significant. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the humpback whale is listed as an endangered species under the ESA.

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