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# THE AGE OF LIVING GRAY WHALES (*Eschrichtius robustus*) ESTIMATED FROM PHOTOGRAPHIC IDENTIFICATION DATA

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## ABSTRACT

The minimum ages of breeding female gray whales were determined from photographs obtained during the periods from 1977-1983 (Jones and Swartz), from 1996-2000, 2003 (Urban et al.), and from 2005-2016 (LSIESP/UABCS). Recaptures (matches) of individual whales were used to estimate their minimum ages as the number of years from the time of the earliest photograph to the most recent. Photographs of 17 "re-captured" whales confirmed 16 female and one presumed male gray whale minimum ages ranging from 26 to 46 years, and confirm that these females are continuing to reproduce and visit Laguna San Ignacio with their new calves each winter. These are the oldest photographic identification data for any living gray whales, clearly demonstrating the fidelity of breeding female gray whales to Laguna San Ignacio, and underscore the value of long-term photographic identification based research.

*Key words: gray whale, photographic identification, minimum age, breeding lagoons, fidelity.*

## INTRODUCTION

Estimating the age of mysticete cetaceans is difficult owing to their longevity and oceanic natural history. Most estimates of age are inferred from the size distribution of harvested whales (Berta et al. 2005, Sumich 2014), whaling artifacts found embedded in harvested whales (George and Bockstoce 2008), and the number of growth layers in the wax ear-plugs of dead mysticetes (Blokhin and Tiupeleyev 1987).

Rice and Wolman estimated the age of harvested female gray whales from the number of corpora albicantia in their ovaries, assuming that the average pregnancy rate is 2-years and produces one corpora albicantia, plus the average age of 8 years for the onset of sexual maturity (Rice and Wolman 1971). The oldest female gray whale they examined had 34 corpora albicantia and was estimated to be 76 years old (34 corpora x 2 = 68 years + 8 years to sexual maturity = 76 years).

Here we report estimates of minimum age for living reproducing female gray whales from the analysis of photographic identification data (Photo-ID) obtained in the winter

aggregation area and breeding lagoon of Laguna San Ignacio in Baja California Sur, Mexico during the whales' winter reproductive seasons from 1977 to the present.

## METHODS

The distinctive and individually unique markings and scars on the backs of gray whales make them excellent subjects for Photo-ID based research because these features persist and are recognizable over long periods of time (Jones 1990). Photographs of gray whales obtained on their winter breeding areas and lagoons of Baja California Mexico during three time periods were compared. The earliest photographs were collected in Laguna San Ignacio by Jones and Swartz (1984) from 1977 to 1983 and included 83 right side and 74 left side images. These were compared with 1,690 right side images obtained from 1996 to 2000 and 2003 by researchers from the Programa de Investigación de Mamíferos Marinos of the Universidad Autónoma de Baja California Sur (UABCS) and 5,630 right side images and 4,250 left side images obtained from 2005 to 2016 by researchers from the Laguna San Ignacio Ecosystem Science Program (LSIESP/UABCS).

The minimum age of individual whales were estimated as the number of years between the first year a whale was photographed and the year of the most recent photographic re-capture of that individual whale. If a whale was first photographed as a female with a calf, it was assumed that whale was at least 8-years old, and 8-years was added to the number of years between the first sighting and the most recent re-capture to account for the average number of years required for that female to attain sexual maturity and begin reproducing.

## RESULTS

The comparison of the 1977-1983 photographs from Laguna San Ignacio revealed matches or re-captures of 17 individual whales with photographs obtained between 1996 and the present. These included 16 breeding females and one (1) whale that was never photographed with a calf and presumed to be a male (Table 1). Ten individuals were first photographed as single whales during the period 1977-1983 and subsequently re-captured one or more times with calves years later, indicating that these females had reached the age of sexual maturity during the period 1977-1996. The estimated minimum ages for these re-captured whales ranged from 26 years to 46 years.

## DISCUSSION

These estimates of gray whale ages are the oldest Photo-ID data for any living gray whales, and further demonstrate that natural occurring markings are a reliable way to identify individual gray whales over long periods of time. These results also confirm that some female gray whales demonstrate a fidelity to the Laguna San Ignacio winter aggregation and breeding area by returning to this breeding lagoon with their calves over many years.

Rice & Wolman (1971) reported that the oldest breeding female gray whale they examined was 76 years old when she was killed. Our estimated age of living breeding females ranges from 26 to 46 years, suggesting that these living females are in the middle of their reproductive lives, and could be expected to live for another 20 to 30 years.

Ten (10) of the 17 re-captured whales were first photographed as single whales between 1977 and 1983, and then later photographed as females with calves, suggesting that they attained reproductive maturity and began reproducing during the period 1977 to 1996.

These findings confirm, and we concur with, the opinion of Jones (1990) that photographic identification based research provides a "unique opportunity" to estimate life history and reproductive parameters from living whales that include: calving interval; regional fidelity, duration of stay in a particular location, habitat use, and longevity. While photographic identification methods require non-lethal, non-invasive research over many years, photographic monitoring of living whales will continue to provide new information on the whales' behavior and reproductive biology throughout their lives.

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Table 1. Re-Captures (matches) of gray whales photographed from 1977 to 2016 in the winter aggregation areas and breeding lagoons of Laguna San Ignacio, Laguna Ojo de Liebre, and Bahía Magdalena. All matches were made with whales photographed in Laguna San Ignacio unless otherwise noted. Minimum ages of individual whales are estimated as the number of years between the first year a whale was photographed and the year of the most recent photographic re-capture of that individual whale. Whales first photographed as a female with a calf were assumed to be at least 8-years old (average of sexual maturity), and 8-years was added to the number of years between the first sighting and the most recent photographic re-capture. S = single adult whale not accompanied by a calf; FC = adult female whale accompanied by a calf.

| Match No. | Whale Image ID No. | Years Photographed (BM=Bahía Magdalena; LOL = Laguna Ojo de Liebre) | Reproductive Status: S = single adult; FC = female & calf | Estimated Age /Years |
|---|---|---|---|---|
| 1 | SI800200-0008R | 1980 | S | |
| | 06-0181-D-LSI-M | 2006 | FC | 26 |
| 2 | SI820216-0038R | 1982 | S | |
| | 10-0749-D-LSI-M | 2010 | FC | 28 |
| 3 | SI780000-0122R | 1978 | S | |
| | 96-0058-D-LSI-M | 1996 | FC | |
| | 06-0023-D-LSI-M | 2006 | FC | 28 |
| 4 | SI820222-0027R-CC | 1982 | FC | |
| | 98-0057-D-LSI | 1998 | S | |
| | 05-0014-D-LSI | 2005 | S | 23 + 8 = 31 |
| 5 | SI810322-0020R | 1981 | S | |
| | 14-0001-D-LOL-M | 2014 | FC | 33 |
| 6 | SI810215-0022R | 1981 | S | |
| | 05-0231-D-LSI-M | 2005 | FC | |
| | 12-0068-D-BM | 2012 | S | |
| | 13-0011-D-BM-M | 2013 | FC | |
| | 15-0089-D-LSI | 2015 | S | 34 |
| 7 | SI790103-0061R-38 | 1979 | S | |
| | SI800106-0093R-38 | 1980 | S | |
| | SI810300-0001R-38 | 1981 | S | |
| | 06-0021-D-LSI-M | 2006 | FC | |

| | | | | |
|---|---|---|---|---|
| | 14-0161-D-LSI | 2014 | S | 35 |
| 8 | SI790103-0062R-41 | 1979 | S | |
| | SI800000-0094R-41 | 1980 | S | |
| | SI810200-0031R-41 | 1981 | S | |
| | 11-0221-D-LSI | 2011 | S | |
| | 13-0245-D-LSI | 2013 | S | |
| | 14-0513-D-LSI | 2014 | S | 35 (presumed male) |
| 9 | SI780000-0130R | 1978 | S | |
| | 14-0708-D-LSI-M | 2014 | FC | 36 |
| 10 | SI780000-0125L | 1978 | S | |
| | 97-0236-D-LSI-M | 1997 | FC | |
| | 98-0369-D-LSI | 1998 | S | |
| | 07-0124-D-LSI-M | 2007 | FC | |
| | 11-0002-D-LSI-M | 2011 | FC | |
| | 13-0452-I-LSI-M | 2013 | FC | |
| | 15-0317-D-LSI-M | 2015 | FC | 37 |
| 11 | SI790125-0001-24 | 1979 | S | |
| | SI800201-0003L-24 | 1980 | S | |
| | SI810115-0001L-24 | 1981 | S | |
| | SI820206-0001L-24 | 1982 | S | |
| | 09-0360-D-LSI | 2009 | S | |
| | 12-0247-D-LSI | 2012 | S | |
| | 14-0720-D-LSI-M | 2014 | FC | |
| | 16-0472-D-LSI-M | 2016 | FC | 37 |
| 12 | SI780103-0001-34 | 1978 | S | |
| | SI790000-0001CCL-34 | 1979 | FC | |
| | SI800000-0088R-34 | 1980 | S | |
| | 08-0128-D-LSI | 2008 | S | |
| | 09-0685-D-LSI-M | 2009 | FC | 31 + 8 = 39 |
| 13 | SI810218-0108LCC | 1981 | FC | |
| | 10-0500-I-LSI | 2010 | S | |
| | 12-0119-D-LSI-M | 2012 | FC | |
| | 15-0421-D-LSI-M | 2015 | FC | 34 + 8 = 42 |
| 14 | SI800000-0004R-CC | 1980 | FC | |
| | 96-0133-D-LSI-M | 1996 | FC | |
| | 99-0270-D-LSI | 1999 | S | |
| | 11-0160-D-LSI | 2011 | S | |
| | 13-0394-D-LSI-M | 2013 | FC | |

| | | | | |
|---|---|---|---|---|
| | 15-0321-D-LSI-M | 2015 | FC | 35 + 8 = 43 |
| 15 | SI790412-0001CCL-22 | 1979 | FC | |
| | SI810219-0005CCL-22 | 1981 | FC | |
| | SI820210-0006L-22 | 1982 | S | |
| | 08-0188-I-LSI | 2008 | S | |
| | 11-0537-D-LSI-M | 2011 | FC | |
| | 14-0787-I-LSI-M | 2014 | FC | 35 + 8 = 43 |
| 16 | SI770400-0001CCL | 1977 | FC | |
| | SI780122-0002 | 1978 | S | |
| | SI790210-0002CCR | 1979 | FC | |
| | SI800200-0005R | 1980 | S | |
| | SI810119-0001CCR / L | 1981 | FC | |
| | SI820210-0001R | 1982 | S | |
| | SI830329-0001CCL | 1983 | FC | |
| | 97-0320-D-LSI | 1997 | S | |
| | 08-0089-D-LSI-M | 2008 | FC | |
| | 10-0658-D-LSI | 2010 | S | |
| | 12-0445-D-LSI | 2012 | S | |
| | 13-0376-D-LSI-M | 2013 | FC | |
| | 15-0192-D-LSI | 2015 | S | 38 + 8 = 46 |
| 17 | SI780121-0001CCL-46 | 1978 | FC | |
| | SI8301-0001L-46 | 1983 | S | |
| | 08-0112-D-LSI-M | 2008 | FC | |
| | 12-0040-D-LSI-M | 2012 | FC | |
| | 13-0111-I-LSI | 2013 | S | |
| | 14-0691-D-LSI-M | 2014 | FC | |
| | 16-0521-D-LSI-M | 2016 | FC | 38 + 8 = 46 |