

## **bh.visual\_census**

This is file **readme.bh.visual\_census.pdf**, which documents the bowhead data archive **bh.visual\_census**.

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### **Introduction**

The zipped archive **bh.visual\_census.zip**, which should unzip into a folder called **bh.visual\_census**, contains data from ice-based visual ‘census’ studies to estimate the abundance of the Bering-Chukchi-Beaufort Seas (BCBS) stock of bowhead whales, *Balaena mysticetus*. These counts take place off Point Barrow, Alaska, in the spring, as the whales migrate from the Bering to the Beaufort Sea. They were conducted annually from 1978 to 1988 and again in 1993 and 2001. Adverse environmental conditions led to counts inadequate to support abundance estimates in 1979 and 1984. The primary document describing each census is given in the reference list below. The most recent of these, George *et al.* (2003), was presented to the International Whaling Commission Scientific Committee (IWC SC) in May 2003 and is available from the IWC Secretariat. George *et al.* (2003) provide a brief summary of the history and methods of the visual census and of methods used to estimate abundance from the data. More detailed accounts of abundance estimation methods and results are included in the reference list below. In particular, the visual census estimate on which  $N_4$  was based was introduced by Zeh *et al.* (1986a,b) and further developed by Zeh *et al.* (1991).  $N_4/P_4$  was first discussed by Raftery and Zeh (1991, 1993).

The data in **bh.visual\_census** provide an estimate  $N_4$  of the number of whales that passed within the 4km visual range of the observation ‘perch’ from which the whales are counted. The IWC SC agreed to use the 2001  $N_4/P_4$  abundance estimate (George *et al.*, 2003) for the 2004 bowhead assessment (Section 9.1.3 of IWC, 2003).  $P_4$ , the estimated proportion of the whales that passed within the 4km visual range, is estimated from data in **bh.acoustic\_locations** and **bh.aerial\_surveys**. Between 1978 and 1985, counts were made from two census perches simultaneously. We refer to the primary perch as South Perch and the other as North Perch.

The field data from the censuses are contained in the formatted text files **sYYxy.new.txt** and **nYYxy.new.txt** in **bh.visual\_census**. **YY** gives the last two digits of the census year, 78-83 and 85 for both South Perch (**s**) files and North Perch (**n**) files, and 86-88, 93, and 01 for South Perch only. The file **format.new.txt** in **bh.visual\_census** briefly describes the format of these files, and **details.new.pdf** provides a more detailed description. Although it did not produce an abundance estimate, 1979 is included because it did provide data for estimating detection probabilities. Data required for computing the positions of whales and the distance offshore from the perch at which they were seen are included in files **perches.txt**, **theodolites.txt**, and **systems.txt** in **bh.visual\_census**; they are described below. Finally, we include the most important computer programs used in computing  $N_4$ , with sample input files, in the archive and describe them below.

## List of files

The **bh.visual\_census** archive includes 31 files in addition to this one. They are as follows:

Date and Time Created or Modified	Length (bytes)	File Name
01/03/2004 08:07p	153,869	details.new.pdf
01/01/2004 04:58p	398	files.78.txt
01/01/2004 09:42p	13,737	fixxy.f
12/29/2003 09:09a	4,869	format.new.txt
01/01/2004 09:10p	313,650	n78xy.new.txt
01/01/2004 09:11p	87,063	n79xy.new.txt
01/01/2004 09:11p	22,908	n80xy.new.txt
01/01/2004 09:11p	93,690	n81xy.new.txt
01/01/2004 09:11p	344,388	n82xy.new.txt
01/01/2004 09:11p	155,307	n83xy.new.txt
01/01/2004 09:11p	135,849	n85xy.new.txt
01/01/2004 04:54p	1,341	perches.txt
01/01/2004 04:59p	204	qdata.half.txt
01/01/2004 04:54p	23,779	rawn.f
01/01/2004 04:55p	92	rawn78.txt
01/02/2004 03:38p	13,437	rawq.f
01/02/2004 03:38p	51	rawq78.txt
01/01/2004 09:12p	1,257,363	s01xy.new.txt
01/01/2004 09:11p	471,006	s78xy.new.txt
01/01/2004 09:11p	170,112	s79xy.new.txt
01/01/2004 09:11p	390,213	s80xy.new.txt
01/01/2004 09:11p	458,880	s81xy.new.txt
01/02/2004 09:12a	599,175	s82xy.new.txt
01/01/2004 09:11p	501,744	s83xy.new.txt
01/01/2004 09:11p	577,884	s85xy.new.txt
01/01/2004 09:11p	895,416	s86xy.new.txt
01/01/2004 09:11p	992,847	s87xy.new.txt
01/01/2004 09:11p	1,086,612	s88xy.new.txt
01/01/2004 09:12p	1,452,084	s93xy.new.txt
01/05/2004 02:16p	6,231	systems.txt
01/01/2004 04:54p	499	theodolites.txt
Total		10,224,698 bytes

## Description of files

With the exception of **details.new.pdf** and **readme.bh.visual\_census.pdf**, all the files in **bh.visual\_census** are Unix text files that can be opened with WordPad. As noted above, the files **sYYxy.new.txt** and **nYYxy.new.txt** are formatted files described in **format.new.txt** and in more detail in **details.new.pdf**. These files and the file **theodolites.txt** do not have headers; **theodolites.txt**, a file containing information about theodolites used to measure distances and bearings to sightings, is also described in **details.new.pdf**. Files **sYYxy.new.txt** and **nYYxy.new.txt** are produced by the Fortran program **fixxy.f**, which copies the raw data in the corresponding input files, fills in blank fields from previous records as appropriate, and uses the raw data to calculate the x- and y-coordinates, number of observers, direction, and speed that appear in columns 84-101, 112-113, and 119-140. If the input file lacks line numbers in columns 114-118, these are also computed by **fixxy.f**. We provide the files produced by this program rather than the raw data files so that all will have the same format and will contain the data used in estimating abundance.

We next describe the other files in **bh.visual\_census** used by **fixxy.f**. The file **files.78.txt** is the sample input file for this program described in comment records at the beginning of **fixxy.f**. It tells **fixxy.f** the census year and the names of files to be used by the program. We do not include the raw data input file **S78data.dat** in **bh.visual\_census**, but you can run the program following the instructions in the comments after copying **s78xy.new.txt** into a file named **S78data.dat**. The other input files used by **fixxy.f** are **theodolites.txt**, **perches.txt**, and **systems.txt**. We have already described **theodolites.txt**.

The file **perches.txt** is a tab-delimited text file with a header and 46 data records. The fields in the data records are *Year*, *PID*, *PerchName*, *PerchX*, and *PerchY*. *Year* is the 4-digit year. *PID* is the perch ID number. *PerchName* is the name of the perch. *PerchX* is meters east of Point Barrow of the perch, so perches west of Point Barrow have negative values of *PerchX*. *PerchY* is meters north of Point Barrow, so perches south of Point Barrow have negative values of *PerchY*.

The file **systems.txt** is a tab-delimited text file with a header and 173 data records. The fields in the data records are *PID*, *StartDay*, *hhmmss*, *DistNS*, *Bear*, *MagN*, and *DistEdgeS*. *PID* is the perch ID number of South Perch. *StartDay* is an 8-digit integer giving the start date of this record, with year in the first 4 digits, month in the next 2, and day in the last 2; *hhmmss* is a 6-digit integer giving the start time on that date, with *hh* the hour, *mm* the minute, and *ss* the second. *DistNS* is the distance (meters) between North Perch and South Perch during the period covered by this record, 0 if there was no North Perch during the period. *Bear* is the magnetic bearing (degrees) from South to North Perch, or from the southernmost to the northernmost hydrophone if a hydrophone array was in operation. *MagN* is the magnetic deviation in degrees. Thus the sum of *Bear* and *MagN* provides an estimate of the true bearing of the nearshore lead edge in degrees measured clockwise from true north. *DistEdgeS* is the distance in meters from South Perch to the nearshore lead edge; 0 values are used when the perch was right on the lead edge or when its distance from the lead edge is unknown.

*DistEdgeS* was not routinely measured and recorded until after 1985, and shifting ice pans sometimes led to changes in its value at a particular perch. A careful examination of lead edge (<sub>LE</sub>) measurements (see **details.new.pdf**) might provide more accurate values than those given in **systems.txt** in some cases. However, *DistEdgeS* provides a rough indicator of whether perches were close to or far from the lead in a given year. It should also be noted that **perches.txt** and **systems.txt** are simplified versions of the history of perch and ice movements in a given season; changes that make no difference to abundance estimates have not always been included. For example, in 1980, several perches were used prior to the time the first bowhead was seen, but we include only the perch used while the whales were passing. Also, in some cases, North Perch was in operation during only part of a period indicated by a record in **systems.txt**; the exact times of North Perch operation are found in the **nYYxy.new.txt** files.

The remaining files in **bh.visual\_census** are the Fortran programs **rawn.f** and **rawq.f** and their input files. Program **rawn.f** computes the daily estimates of the number of whales that passed within visual range during a particular census year; these daily estimates provide the input to the time series interpolator presently used to calculate  $N_4$ . The sample input file **rawn78.txt** described in comments at the beginning of **rawn.f** is included in **bh.visual\_census**, as is a sample file of percent missed data, **qdata.half.txt**. See **rawn.f** for details about these files. Program **rawq.f** extracts from North Perch and South Perch files the data for fitting a generalized linear model that provides the percent missed data (Zeh *et al.*, 1991); **rawq78.txt** is the sample input file described in comments at the beginning of **rawq.f**. Since some data and program errors were discovered and corrected in the process of constructing **bh.visual\_census**, we expect that our analyses of these data, not yet complete, will result in some changes to **qdata.half.txt** and the abundance estimates  $N_4$ , but we do not expect substantial changes.

## References

- Braham, H., Krogman, B., Leatherwood, S., Marquette, W., Rugh, D., Tillman, M., Johnson, J. and Carroll, G.M. 1979. Preliminary report of the 1978 spring bowhead whale research program results. *Rep. int. Whal. Commn* 29:291-306.
- Braham, H., Krogman, B., Johnson, J., Marquette, W., Rugh, D., Nerini, M., Sonntag, R., Bray, T., Brueggeman, J., Dahlheim, M., Savage, S. and Goebel, C. 1980. Population studies of the bowhead whale (*Balaena mysticetus*): results of the 1979 spring research season. *Rep. int. Whal. Commn* 30:391-404.
- Dronenburg, R.B., Carroll, G.M., Rugh, D.J. and Marquette, W.M. 1983. Report of the 1982 spring bowhead whale census and harvest monitoring including 1981 fall harvest results. *Rep. int. Whal. Commn* 33:525-37.
- Dronenburg, R.B., Carroll, G.M., George, J.C., Sonntag, R.M., Krogman, B.D. and Zeh, J.E. 1984. Final report of the 1983 spring bowhead whale census and harvest monitoring including 1982

- fall harvest results. *Rep. int. Whal. Commn* 34:433-44.
- Dronenburg, R.B., George, J.C., Krogman, B.D., Sonntag, R.M. and Zeh, J.E. 1986. Report of the 1984 spring bowhead whale (*Balaena mysticetus*) ice-based visual census. *Rep. int. Whal. Commn* 36:293-8.
- George, J.C., Carroll, G.M., Tarpley, R.J., Albert, T.F. and Yackley, R. 1987. Report of field activities pertaining to the spring 1986 census of bowhead whales, *Balaena mysticetus*, off Pt. Barrow, Alaska with observations on the subsistence hunt. *Rep. int. Whal. Commn* 37:301-8.
- George, J.C., Carroll, G.M. and Philo, L.M. 1988. Preliminary report on bowhead whale, *Balaena mysticetus*, census-related field activities during spring 1987 off Point Barrow, Alaska. *Rep. int. Whal. Commn* 38:393-99.
- George, J.C., Carroll, G.M., Philo, L.M. and Albert, T.F. 1990. Report of field activities of the spring 1988 census of bowhead whales (*Balaena mysticetus*) off Point Barrow, Alaska with observations on the subsistence hunt. *Rep. int. Whal. Commn* 40:383-91.
- George, J.C., Suydam, R.S., Philo, L.M., Albert, T.F., Zeh, J.E. and Carroll, G.M. 1995. Report of the spring 1993 census of bowhead whales, *Balaena mysticetus*, off Point Barrow, Alaska with observations on the 1993 subsistence hunt of bowhead whales by Alaska Eskimos. *Rep. int. Whal. Commn* 45:371-86.
- George, J.C., Zeh, J., Suydam, R. and Clark, C. 2003.  $N_4/P_4$  abundance estimate for the Bering-Chukchi-Beaufort Seas stock of bowhead whales (*Balaena mysticetus*) based on the 2001 census off Point Barrow, Alaska. Paper SC/55/BRG7 presented to the IWC SC, May 2003. 16pp.
- International Whaling Commission. 2003. Report of the Scientific Committee. 66pp.
- Johnson, J.H., Braham, H.W., Krogman, B.D., Marquette, W.M., Sonntag, R.M., and Rugh, D.J. 1981. Bowhead whale research: June 1979 to June 1980. *Rep. int. Whal. Commn* 31:461-75.
- Krogman, B., George, J.C., Carroll, G., Zeh, J. and Sonntag, R. 1986. Preliminary results of the 1985 spring ice-based census of the bowhead whale, *Balaena mysticetus*, conducted near Point Barrow, Alaska. *Rep. int. Whal. Commn* 36:343-52.
- Marquette, W.M., Braham, H.W., Nerini, M.K. and Miller, R.V. 1982. Bowhead whale studies, autumn 1980—spring 1981: harvest, biology and distribution. *Rep. int. Whal. Commn* 32:357-70.
- Raftery, A.E. and Zeh, J.E. 1991. Bayes empirical Bayes estimation of bowhead whale population size based on the visual and acoustic census near Barrow, Alaska, in 1986 and 1988. Paper SC/43/PS8 presented to the IWC SC, May 1991. 51pp.

- Raftery, A.E. and Zeh, J.E. 1993. Estimation of bowhead whale, *Balaena mysticetus*, population size. pp. 163-225 In: C. Gatsonis, J.S. Hodges, R.E. Kass, and N.D. Singpurwalla (eds). *Case Studies in Bayesian Statistics*. Springer-Verlag, New York. xiv + 437pp.
- Raftery, A.E. and Zeh, J.E. 1998. Estimating bowhead whale population size and rate of increase from the 1993 census. *J. Am. Sta. Assoc.* 93:451-63.
- Zeh, J., Ko, D., Krogman, B. and Sonntag, R. 1986a. A multinomial model for estimating the size of a whale population from incomplete census data. *Biometrics* 42:1-14.
- Zeh, J.E., Ko, D., Krogman, B.D. and Sonntag, R.M. 1986b. Statistical considerations in estimating the number of bowhead whales, *Balaena mysticetus*, from ice-based visual census data. *Rep. int. Whal. Commn* 36:317-23.
- Zeh, J.E., George, J.C., Raftery, A.E. and Carroll, G.M. 1991. Population size and rate of increase, 1978-1988, of bowhead whales, *Balaena mysticetus*, estimated from ice-based census data. *Mar. Mammal Sci.* 7:105-22.
- Zeh, J.E., Clark, C.W., George, J.C., Withrow, D., Carroll, G.M. and Koski, W.R. 1993. Current population size and dynamics. pp 409-89. In: J.J. Burns, J.J. Montague and C.J. Cowles (eds). *The Bowhead Whale*. Special publication No. 2 of the Society of Marine Mammalogy. i-xxxvi + 787pp.