Age Comparisons Assignment

Herbst and Marsden (2012) (reprint is here) compared the precision, bias, and reader uncertainty of scales, dorsal fin rays, and otolith age estimates from 151 lake whitefish (*Coregonus clupeaformis*) from Lake Champlain in 2009. The data for their comparisons were recorded in `WhitefishLC.csv`. This file contains inital age assessments for two readers on three structures (variable names are the structure name with a "1" or "2" appended to denote the reader). In addition, the two readers developed a consensus age (variable name is the structure name with a "C" appended).

```
> setwd("C:/aaaWork/Web/fishR/Courses/MNAFS2013/CourseMaterial")
> wf <- read.csv("WhitefishLC.csv",header=TRUE)
> str(wf)
'data.frame': 151 obs. of  11 variables:
 $ fishID  : int  1 2 3 4 5 6 7 8 9 10 ...
 $ tl      : int  345 334 348 300 330 316 508 475 340 173 ...
 $ scale1  : int  3 4 7 4 3 4 6 4 3 1 ...
 $ scale2  : int  3 3 5 3 3 4 7 5 3 1 ...
 $ scaleC  : int  3 4 6 4 3 4 7 5 3 1 ...
 $ finray1 : int  3 3 3 3 4 2 6 9 2 2 ...
 $ finray2 : int  3 3 3 2 3 3 6 9 3 1 ...
 $ finrayC : int  3 3 3 3 4 3 6 9 3 1 ...
 $ otolith1: int  3 3 3 3 3 6 9 11 3 1 ...
 $ otolith2: int  3 3 3 3 3 5 10 12 4 1 ...
 $ otolithC: int  3 3 3 3 3 6 10 11 4 1 ...
```

1. Use a variety of methods (tabular, graphical, and statistical) to describe any apparent bias in *consensus* ages between scales and otoliths.

```
> ac1 <- ageComp(otolithC~scaleC,data=wf,col.lab="Otolith Age",row.lab="Scale Age")
> summary(ac1,what="symmetry",flip.table=TRUE)
Raw agreement table (square & flipped)
          Otolith Age
Scale Age  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
       23  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       22  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       21  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       20  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       19  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       18  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       17  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       16  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       15  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  1  -  -  -  -  -  -  -
       14  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  1  -  -  -  1  -  -  -
       13  -  -  -  -  -  -  -  -  -  -  -  -  -  1  1  -  1  1  1  -  -  -  -
       12  -  -  -  -  -  -  -  -  -  -  -  -  1  -  -  1  1  -  -  -  -  -  -
       11  -  -  -  -  -  -  -  -  -  -  -  -  1  -  1  -  2  -  -  -  -  -  -
       10  -  -  -  -  -  -  1  -  -  -  -  1  1  -  -  1  -  -  -  -  -  -  1
        9  -  -  -  -  -  -  -  -  -  -  1  1  1  -  2  -  1  -  -  -  -  -  -
        8  -  -  -  -  1  -  1  1  3  3  3  1  -  -  -  -  -  -  -  -  -  -  -
        7  -  -  -  -  -  -  1  3  6  4  2  2  1  1  -  -  -  1  -  -  -  -  -
        6  -  -  1  1  2  1  3  4  1  2  1  1  2  1  -  -  -  -  -  -  -  -  -
        5  -  1  -  3  2  5  3  4  -  -  1  -  -  -  -  -  -  -  -  -  -  -  -
        4  -  -  5  7  3  3  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        3  -  1 10  6  -  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        2  4  1  -  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
```

```
        1   5  4  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -

Bowker's (Hoenig's) Test of Symmetry
 df chi.sq       p
 54  75.98 0.02598

> summary(ac1,what="bias")

Summary of Scale Age by Otolith Age
 otolithC  n min max   mean     SE        t   adj.p sigDiff
        1  9   1    2  1.444 0.1757   2.5298 0.31740
        2  7   1    5  2.000 0.5773   0.0000 1.00000
        3 17   1    6  3.353 0.2416   1.4604 0.98115
        4 18   2    6  3.833 0.2322  -0.7179 1.00000
        5  8   4    8  5.250 0.4910   0.5092 1.00000
        6 10   3    6  4.600 0.2667  -5.2498 0.00739     yes
        7  9   5   10  6.444 0.5556  -1.0001 1.00000
        8 12   5    8  6.083 0.2876  -6.6650 0.00057     yes
        9 10   6    8  7.200 0.2000  -8.9994 0.00015     yes
       10  9   6    8  7.111 0.2606 -11.0870 0.00007     yes
       11  8   5    9  7.250 0.4531  -8.2754 0.00110     yes
       12  7   6   12  8.429 0.7825  -4.5643 0.04983     yes
       13  7   6   13  8.857 1.0101  -4.1013 0.06983
       14  3   6   13  8.667 2.1858  -2.4400 0.94373
       15  5   9   14 11.000 0.9487  -4.2164 0.13516
       16  4  10   15 12.500 1.0409  -3.3626 0.34918
       17  4   9   13 11.000 0.8165  -7.3484 0.06250
       18  2   7   13 10.000 3.0000  -2.6667 1.00000
       19  1  14   14 14.000     NA      NA      NA
       23  1  10   10 10.000     NA      NA      NA

> plot(ac1,xlim=c(0,25),ylim=c(0,25))
```


The age-agreement table is significantly asymmetric ($p = 0.0260$). Otolith ages appear to be significantly greater than scale age from age-6 on, with the exception of age-7 and also noting that significance is difficult to determine for ages beyond age-13 because of small sample sizes.

2. Describe any apparent bias in age assessment for otoliths between the two readers.

```
> ac2 <- ageComp(otolith1~otolith2,data=wf,col.lab="Reader 1",row.lab="Reader 2")
> summary(ac2,what="symmetry",flip.table=TRUE)

Raw agreement table (square & flipped)
         Reader 1
Reader 2  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
```

2

```
 23  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  1
 22  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
 21  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
 20  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
 19  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
 18  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  1  1  1  -  -  -  -
 17  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  2  2  -  -  -  -  -
 16  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  2  -  -  -  -  -  -
 15  -  -  -  -  -  -  -  -  -  -  -  -  -  1  3  3  -  -  -  -  -  -
 14  -  -  -  -  -  -  -  -  -  -  -  -  1  -  2  -  -  -  -  -  -  -
 13  -  -  -  -  -  -  -  -  -  -  -  -  2  4  2  -  -  -  -  -  -  -
 12  -  -  -  -  -  -  -  -  -  -  2  5  -  -  -  -  -  -  -  -  -
 11  -  -  -  -  -  -  -  -  1  3  3  1  1  -  -  -  -  -  -  -  -
 10  -  -  -  -  -  -  -  1  2  4  -  -  -  -  -  -  -  -  -  -  -
  9  -  -  -  -  -  -  -  1  5  2  -  -  -  -  -  -  -  -  -  -  -
  8  -  -  -  -  -  -  1  8  1  2  -  -  -  -  -  -  -  -  -  -  -
  7  -  -  -  -  -  1  6  2  2  -  -  -  -  -  -  -  -  -  -  -  -
  6  -  -  -  -  2  6  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -
  5  -  -  -  3  3  3  -  -  -  -  -  -  -  -  -  -  -  -  -  -
  4  -  -  3 12  2  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -
  3  -  3 12  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
  2  -  6  3  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
  1  9  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
```

```
Bowker's (Hoenig's) Test of Symmetry
 df chi.sq    p
 23   25.4 0.33

> summary(ac2,what="bias")


Summary of Reader 2 by Reader 1
 otolith1  n min max   mean     SE       t adj.p sigDiff
        1  9   1   1  1.000     NA      NA    NA
        2  9   2   3  2.333 0.1667  1.9998     1
        3 18   2   4  3.000 0.1400  0.0000     1
        4 15   4   5  4.200 0.1069  1.8710     1
        5  7   4   6  5.000 0.3086  0.0000     1
        6 11   4   7  5.636 0.2439 -1.4906     1
        7  8   6   8  7.000 0.1890  0.0000     1
        8 12   7  10  8.083 0.2289  0.3639     1
        9 11   7  11  8.909 0.3681 -0.2469     1
       10 11   8  11  9.727 0.3328 -0.8195     1
       11  5  11  12 11.400 0.2449  1.6331     1
       12  9  11  14 12.333 0.2887  1.1546     1
       13  5  11  13 12.600 0.4000 -1.0000     1
       14  5  13  15 13.800 0.3742 -0.5345     1
       15  3  15  15 15.000     NA      NA    NA
       16  7  15  17 15.857 0.3401 -0.4202     1
       17  3  17  18 17.333 0.3334  0.9998     1
       18  1  18  18 18.000     NA      NA    NA
       19  1  18  18 18.000     NA      NA    NA
       23  1  23  23 23.000     NA      NA    NA

> plot(ac2,xlim=c(0,25),ylim=c(0,25))

Warning:  no non-missing arguments to min; returning Inf
Warning:  no non-missing arguments to max; returning -Inf
```
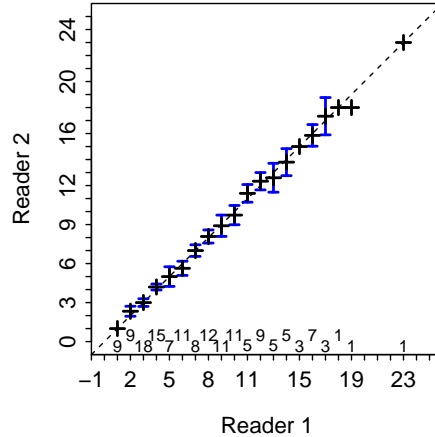
Reader 1

The age-agreement table appears to be symmetric ($p = 0.3300$) and there is no significant difference in assessed ages at any age between the two readers. The ages are, on average, the same from the two readers.

3. Describe precision of age assessment between the two readers for otoliths.

```
> summary(ac2,what="prec.stats")


Percentage by absolute differences in age
    0     1     2
62.25 31.79  5.96


Precision summary statistics
   n agree   APE    CV
 151 62.25 3.337 4.719
```

The two readers agreed on age 62.3% of the time and were within one year 94.0% of the time. Using the criterion of Campana(2001), the age assessments from otoliths were precise (i.e., the CV=4.7<5.)

4. (*Time Permitting*) Describe any apparent bias in age assessment for scales between the two readers.

```
> ac3 <- ageComp(scale1~scale2,data=wf,col.lab="Reader 1",row.lab="Reader 2")
> summary(ac3,what="symmetry",flip.table=TRUE)

Raw agreement table (square & flipped)
         Reader 1
Reader 2  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
      16  -  -  -  -  -  -  -  -  -  -  -  -  -  1  -  -
      15  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
      14  -  -  -  -  -  -  1  -  -  -  -  -  -  1  -  -
      13  -  -  -  -  -  1  -  1  -  -  -  -  3  -  -  -
      12  -  -  -  -  -  -  -  -  -  -  -  1  -  1  1  -
      11  -  -  -  -  -  -  -  -  -  -  1  1  1  1  -  1  -
      10  -  -  -  1  -  -  -  3  1  1  1  -  -  -  -  -
       9  -  -  -  -  -  -  1  -  -  -  1  -  -  -  -  -
       8  -  -  -  -  3  -  1  5  1  1  -  -  -  -  -  -
       7  -  -  -  -  6  5  7  3  1  1  -  -  -  -  -  -
       6  -  -  -  2  1  6  4  1  1  -  -  -  -  -  -  -
       5  -  -  1  4  9  5  1  1  -  -  -  -  -  -  -  -
       4  -  -  2  8  3  1  1  -  -  -  -  -  -  -  -  -
       3  -  1 14  7  -  -  -  -  -  -  -  -  -  -  -  -
       2  -  3  2  -  -  1  -  -  -  -  -  -  -  -  -  -
       1 10  2  1  -  -  -  -  -  -  -  -  -  -  -  -  -
```

```
Bowker's (Hoenig's) Test of Symmetry
 df chi.sq       p
 33  34.94 0.3761

> summary(ac3,what="bias")


Summary of Reader 2 by Reader 1
 scale1  n min max   mean      SE       t   adj.p sigDiff
      1 10   1   1  1.000      NA      NA      NA
      2  6   1   3  1.833 0.3073 -0.5424 1.00000
      3 20   1   5  3.000 0.1777  0.0000 1.00000
      4 22   3  10  4.318 0.3380  0.9415 1.00000
      5 22   4   8  5.864 0.2890  2.9881 0.09814
      6 19   2  13  6.053 0.4805  0.1095 1.00000
      7 16   4  14  7.062 0.5437  0.1150 1.00000
      8 14   5  13  8.214 0.5364  0.3995 1.00000
      9  4   6  10  7.750 0.8539 -1.4639 1.00000
     10  4   7  11  9.000 0.9129 -1.0955 1.00000
     11  3   9  11 10.000 0.5774 -1.7321 1.00000
     12  2  11  12 11.500 0.5000 -1.0000 1.00000
     13  4  11  13 12.500 0.5000 -1.0000 1.00000
     14  3  12  16 14.000 1.1547  0.0000 1.00000
     15  2  11  12 11.500 0.5000 -7.0001 1.00000

> plot(ac3,xlim=c(0,16),ylim=c(0,20))

Warning:  no non-missing arguments to min; returning Inf
Warning:  no non-missing arguments to max; returning -Inf
```
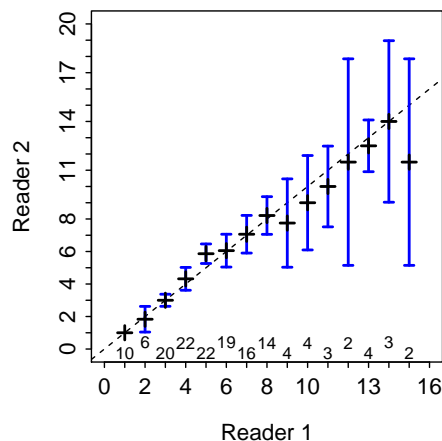

The age-agreement table appears to be symmetric ($p = 0.3761$) and there is no significant difference in assessed ages at any age between the two readers. The ages are, on average, the same from the two readers.

5. (*Time Permitting*) Describe precision of age assessment between the two readers for scales.

```
> summary(ac3,what="prec.stats")


Percentage by absolute differences in age
       0        1        2        3        4        5        6        7
 45.6954 29.8013 15.2318   5.2980   1.3245   0.6623   0.6623   1.3245


Precision summary statistics
    n agree    APE    CV
 151   45.7  8.259 11.68
```

The two readers agreed on age only 45.7% of the time and were within two years 90.7% of the time. The maximum difference in age assessment was 7. Using the criterion of Campana(2001), the age assessments from scales were NOT precise (i.e., the CV=11.7>5.)

6. (*Time Permitting*) Use a variety of methods (tabular, graphical, and statistical) to describe any apparent bias in *consensus* ages between fin rays and otoliths.

```
> ac4 <- ageComp(otolithC~finrayC,data=wf,col.lab="Otolith Age",row.lab="Fin Ray Age")
> summary(ac4,what="symmetry",flip.table=TRUE)
Raw agreement table (square & flipped)
            Otolith Age
Fin Ray Age  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
        23   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        22   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        21   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        20   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        19   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        18   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        17   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        16   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        15   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        14   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  1  -  -  -  -  -  -
        13   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
        12   -  -  -  -  -  -  -  -  -  -  -  -  -  1  2  -  -  -  -  -  -  -  -
        11   -  -  -  -  -  -  -  -  -  -  -  -  1  -  -  2  2  -  -  -  -  -  -
        10   -  -  -  -  -  -  -  -  1  -  -  -  1  -  2  1  1  -  1  -  -  -  -
         9   -  -  -  -  -  -  -  -  -  -  2  1  1  1  -  -  1  1  -  -  -  -  1
         8   -  -  -  -  -  -  -  -  1  1  2  1  2  -  1  -  -  -  -  -  -  -  -
         7   -  -  -  -  -  -  1  2  2  4  3  5  1  1  -  -  -  1  -  -  -  -  -
         6   -  -  -  -  -  4  4  8  4  4  -  -  1  -  -  -  -  -  -  -  -  -  -
         5   -  -  -  -  3  1  3  2  2  -  1  -  -  -  -  -  -  -  -  -  -  -  -
         4   -  1  1  8  4  4  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
         3   1  1 14  9  1  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
         2   2  1  2  1  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
         1   6  4  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -


Bowker's (Hoenig's) Test of Symmetry
 df chi.sq        p
 53  100.4 9.178e-05

> summary(ac4,what="bias")

Summary of Fin Ray Age by Otolith Age
 otolithC  n min max   mean     SE         t  adj.p sigDiff
        1  9   1   3  1.444 0.2422   1.8351 0.33916
        2  7   1   4  1.857 0.4592  -0.3112 1.00000
        3 17   2   4  2.941 0.1040  -0.5655 1.00000
        4 18   2   4  3.389 0.1432  -4.2664 0.00678     yes
        5  8   3   5  4.250 0.2500  -3.0000 0.11965
        6 10   3   6  4.800 0.3590  -3.3425 0.06901
        7  9   4   7  5.556 0.2940  -4.9135 0.01174     yes
        8 12   5   7  6.000 0.1741 -11.4896 0.00000     yes
        9 10   5  10  6.600 0.4761  -5.0412 0.00838     yes
       10  9   6   8  6.667 0.2357 -14.1421 0.00001     yes
       11  8   5   9  7.500 0.4629  -7.5609 0.00196     yes
       12  7   7   9  7.429 0.2974 -15.3721 0.00008     yes
       13  7   6  11  8.429 0.6494  -7.0392 0.00575     yes
       14  3   7  12  9.333 1.4530  -3.2119 0.33916
```
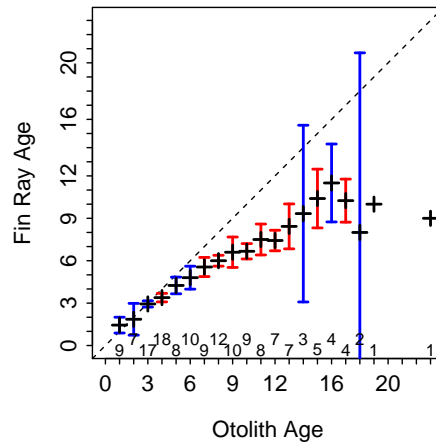
```
       15   5    8   12 10.400 0.7483   -6.1471 0.03197       yes
       16   4   10   14 11.500 0.8660   -5.1960 0.09694
       17   4    9   11 10.250 0.4787  -14.1007 0.00850       yes
       18   2    7    9  8.000 1.0000  -10.0001 0.31725
       19   1   10   10 10.000      NA        NA      NA
       23   1    9    9  9.000      NA        NA      NA

> plot(ac4,xlim=c(0,23),ylim=c(0,23))
```


The age-agreement table is significantly asymmetric ($p = 0.0001$). Otolith ages appear to be significantly greater than fin ray age from age 7 on, but also noting that significance is difficult to determine for ages beyond age-14 because of small sample sizes. Also, note that fin ray age for age-4 otoliths were significantly less than 4, indicating that the divergence in ages could begin as early as age-4.

7. (*Time Permitting*) Describe any apparent bias in age assessment for fin rays between the two readers.

```
> ac5 <- ageComp(finray1~finray2,data=wf,col.lab="Reader 1",row.lab="Reader 2")
> summary(ac5,what="symmetry",flip.table=TRUE)

Raw agreement table (square & flipped)
          Reader 1
Reader 2  1  2  3  4  5  6  7  8  9 10 11 12 13 14
       14  -  -  -  -  -  -  -  -  -  -  -  -  -  1
       13  -  -  -  -  -  -  -  -  -  -  -  -  -  -
       12  -  -  -  -  -  -  -  -  -  -  -  1  1  -  -
       11  -  -  -  -  -  -  -  -  -  1  1  2  -  1  -
       10  -  -  -  -  -  -  -  -  -  5  -  1  1  -  -
        9  -  -  -  -  -  -  2  -  3  2  -  1  -  1  -
        8  -  -  -  1  -  3  5  3  1  1  -  -  -  -
        7  -  -  -  -  2  6  7  -  -  -  -  -  -  -
        6  -  -  -  2  9 14  2  -  -  -  -  -  -  -
        5  -  -  -  -  4  -  1  -  -  -  -  -  -  -
        4  -  -  1 16  4  -  -  -  -  -  -  -  -  -
        3  -  4 22  2  -  -  -  -  -  -  -  -  -  -
        2  -  5  2  -  -  -  -  -  -  -  -  -  -  -
        1  8  2  -  -  -  -  -  -  -  -  -  -  -  -


Bowker's (Hoenig's) Test of Symmetry
 df chi.sq        p
 21  42.33 0.00382

> summary(ac5,what="bias")


Summary of Reader 2 by Reader 1
```

```
finray1  n min max   mean      SE        t   adj.p sigDiff
      1  8   1   1  1.000      NA       NA      NA
      2 11   1   3  2.182 0.22637   0.8031 1.00000
      3 25   2   4  2.960 0.07024 -0.5695 1.00000
      4 21   3   8  4.286 0.24045   1.1882 1.00000
      5 19   4   7  5.474 0.22123   2.1413 0.50807
      6 25   6   9  6.720 0.19596   3.6742 0.01434     yes
      7 15   5   8  7.067 0.22817   0.2923 1.00000
      8  6   8   9  8.500 0.22360   2.2362 0.68020
      9  9   8  11  9.667 0.28867   2.3096 0.50807
     10  2   8  11  9.500 1.49999 -0.3333 1.00000
     11  5   9  12 10.600 0.50991 -0.7844 1.00000
     12  2  10  12 11.000 0.99999 -1.0000 1.00000
     13  2   9  11 10.000 0.99999 -3.0000 1.00000
     14  1  14  14 14.000      NA       NA      NA
> plot(ac5,xlim=c(0,15),ylim=c(0,15))
```
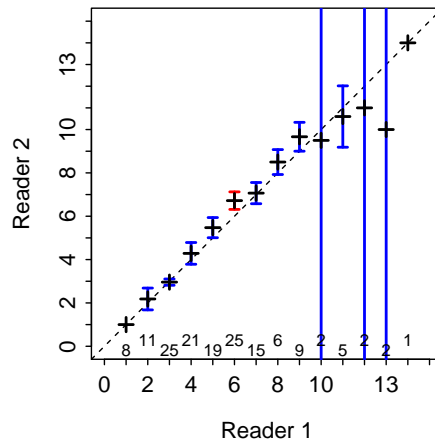

The age-agreement table appears to be asymmetric ($p = 0.0038$), with some evidence for slightly greater ages from reader 2 for ages 4 to 9 for reader 1 and slightly younger ages for ages 11-13 for reader 1. The only significant difference was that the mean assessed age for reader 2 was greater than 6 for reader 1's age-6 fish.

8. (*Time Permitting*) Describe precision of age assessment between the two readers for fin rays.

```
> summary(ac5,what="prec.stats")


Percentage by absolute differences in age
     0      1      2      3      4
56.291 32.450  8.609  1.325  1.325


Precision summary statistics
   n agree   APE    CV
 151 56.29 5.214 7.373
```

The two readers agreed on age 56.3% of the time and were within one year 88.7% of the time. Using the criterion of Campana(2001), the age assessments from otoliths were somewhat imprecise (i.e., the CV=7.4>5.)