Determining Selectivities for Small Coastal Shark Species for Assessment Purposes
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Summary: Selectivities of catch series and indices had to be determined for sharpnose, blacknose, and bonnethead sharks for the 2007 small coastal shark stock assessment. Based on age frequencies, five selectivities were determined for sharpnose, four for blacknose, and two for bonnethead.

Introduction: In order to estimate the selectivity of a certain fishery for a fish species, the age of full selectivity must be determined. This age can be found by plotting a histogram of age frequencies. With natural mortality operating alone, one would expect to see a decline at each age in the histogram. With both natural and fishing mortality operating, what is observed instead is an increase in the age frequency that reflects the increase in selectivity with age. Beyond the "fully selected" age, all subsequent ages are expected to consistently decline because they are all assumed to experience the same fishing and natural mortality. Thus, the fully selected age is determined by looking at the age frequency distribution and identifying the "fulcrum" age class, where younger ages show an increasing frequency and all subsequent ages decrease in frequency.

Methods: We obtained age frequencies by back-transforming the lengths into ages through growth curves or through age-length keys based on the multiple length frequencies provided by the Life History and Indices Working Groups at the Data Workshop. For age-length keys, the procedure consists of determining the proportion of sharks at each age within a series of equal length classes covering the full range of lengths in the original aging study for each species. The sample of interest is then divided into the same length classes and the number of sharks within each length class is assigned to ages based on the proportion of each age in that length class in the age-length key. The final step is to sum the number of sharks of each age across all the length classes. This approach captures variation in age-at-length that is not captured when back-transforming lengths into ages through a growth curve.

The following assumptions are generally made about selectivities:

Longlines: logistic
Gillnets: dome-shaped (double logistic or gamma)
Hook and line: logistic
Trawl nets: dome-shaped (double logistic or gamma)

For each of the species below, we obtained the age-frequencies and plotted histograms for each series. If two histograms appeared to have the same type of selectivity (logistic or double logistic) and the same age of full selectivity, the age frequencies were lumped to find the parameters for the model (a_{50}(s) and slope(s)).

Results:

Sharpnose shark, *Rhizoprionodon terraenovae*

We found five unique selectivities based on 19 age-frequency histograms. We grouped selectivities in the following manor:

Series	Fulcrum age	Type
BLLOP-SA	5	logistic
VA-LL	5	logistic
UNC	5	logistic
SCDNR	5	logistic
BLLOP-GOM	3	logistic
NMFS-LL SE	3	logistic
TX	1	dome
MS GN	1	dome
PC GN	1	dome
PC LL	1	dome
SC GN	1	dome
SEAMAP GOM	1	dome
SEAMAP SA	1	dome
DGNOP	5	dome
MML	2	dome

The age-frequencies were then grouped by combining all the individuals of the same age into selectivity-specific histograms (Figure 1-5).
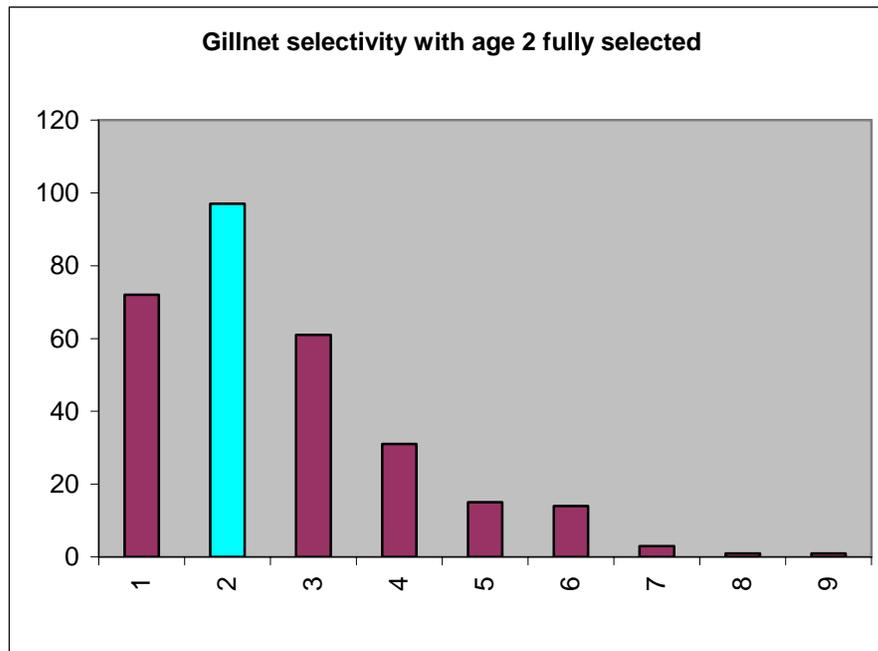
Figure 1. Combined age frequencies of gillnet or "gillnet-like" selectivities for sharpnose that are fully selected at age 2. (N = 295)
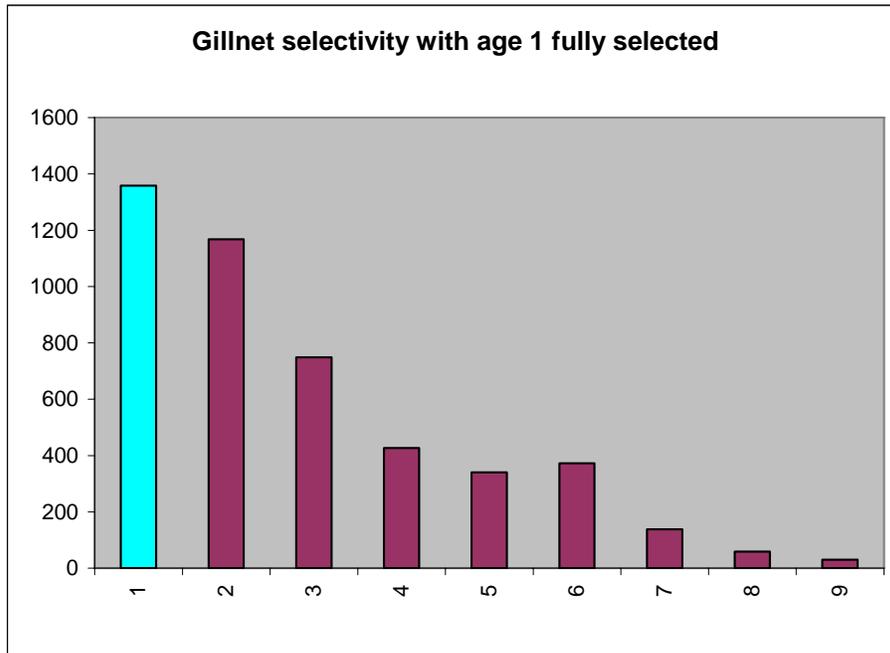
Gillnet selectivity with age 1 fully selected

Figure 2. Combined age frequencies of gillnet or "gillnet-like" selectivities for sharpnose that are fully selected at age 1. (N = 4640)
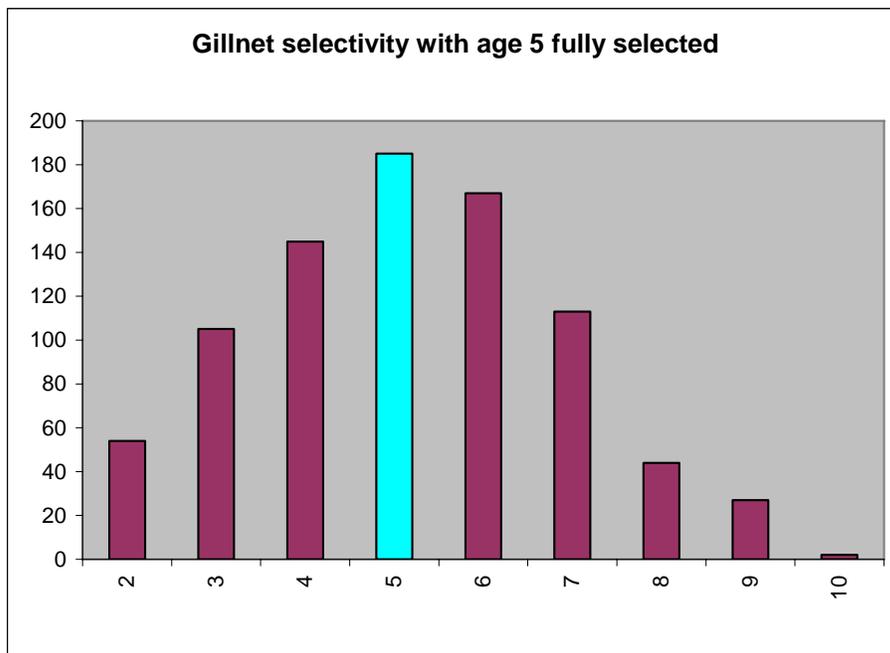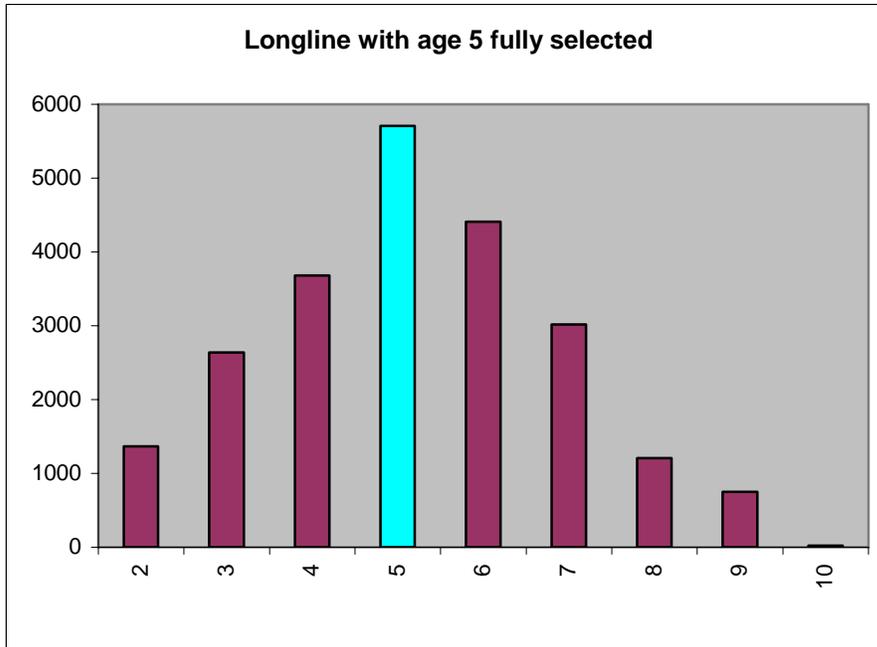
Gillnet selectivity with age 5 fully selected

Figure 3. Combined age frequencies of gillnet or "gillnet-like" selectivities for sharpnose that are fully selected at age 5. (N = 872)

Longline with age 5 fully selected

Figure 4. Combined age frequencies of longline or "longline-like" selectivities for sharpnose that are fully selected at age 5. (N = 23749)

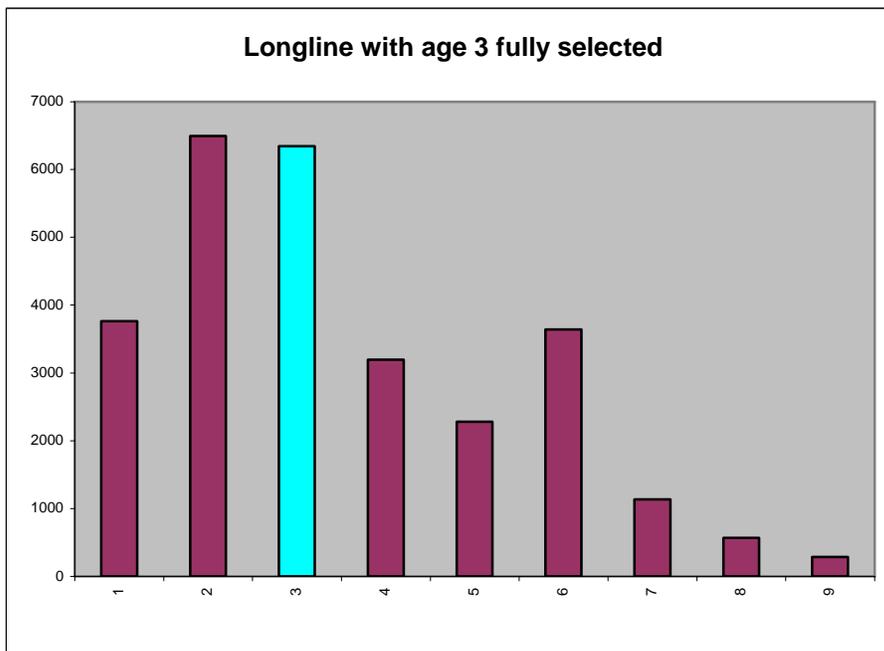**Longline with age 3 fully selected**

Figure 5. Combined age frequencies of longline or "longline-like" selectivities for sharpnose that are fully selected at age 3. (N = 27700)

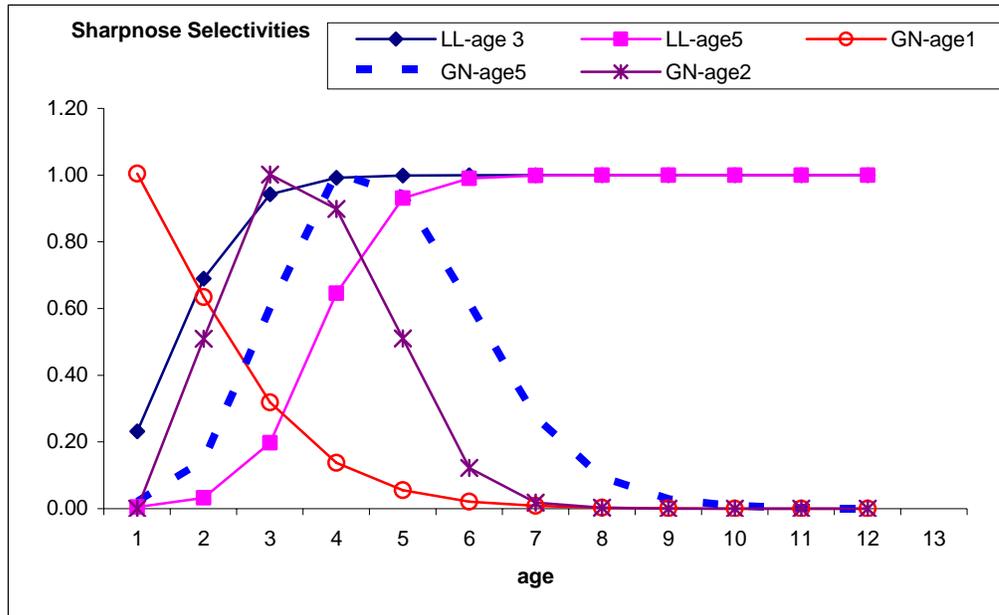This grouping resulted in the following selectivities (Figure 6)

Figure 6. The five selectivities used for sharpnose shark in the 2007 small coastal shark assessment. The assessment document contains the parameters for each curve.

Blacknose shark, *Carcharhinus acronotus*:

We found four unique selectivities based on eight age-frequency histograms. We grouped selectivities in the following manor:

Series	Fulcrum age	Type
BLLOP	2	logistic
UNC	5	logistic
SCDNR	2	logistic
NMFS-LL SE	2	logistic
PC GN	2	dome
PC LL	2	dome
DGNOP	6	dome
MML	6	dome

The age-frequencies were then grouped by combining all the individuals of the same age into selectivity-specific histograms (Figure 6-9). We chose age six as a fulcrum age because we thing the peaks after age 6 are an artifact of the age-length key.
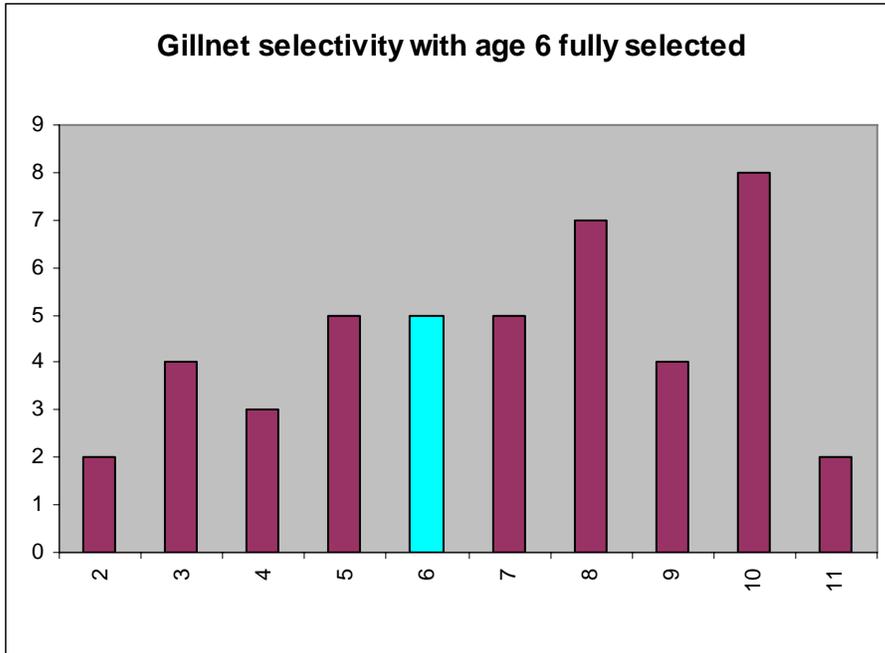
Gillnet selectivity with age 6 fully selected

Figure 6. Combined age frequencies of gillnet or "gillnet-like" selectivities for blacknose that are fully selected at age 6. (N = 46)
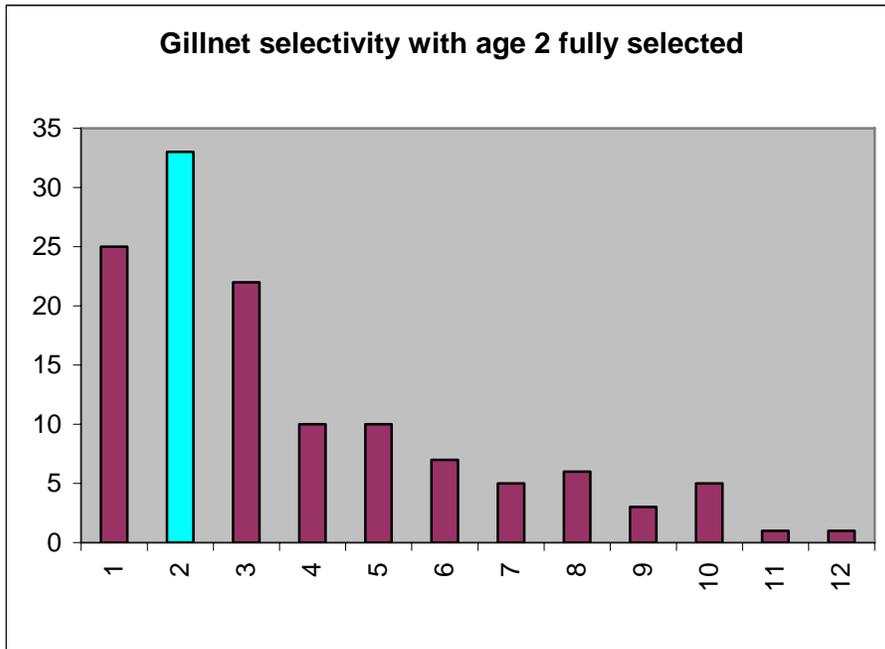
Gillnet selectivity with age 2 fully selected

Figure 7. Combined age frequencies of gillnet or "gillnet-like" selectivities for blacknose that are fully selected at age 2. (N = 103)
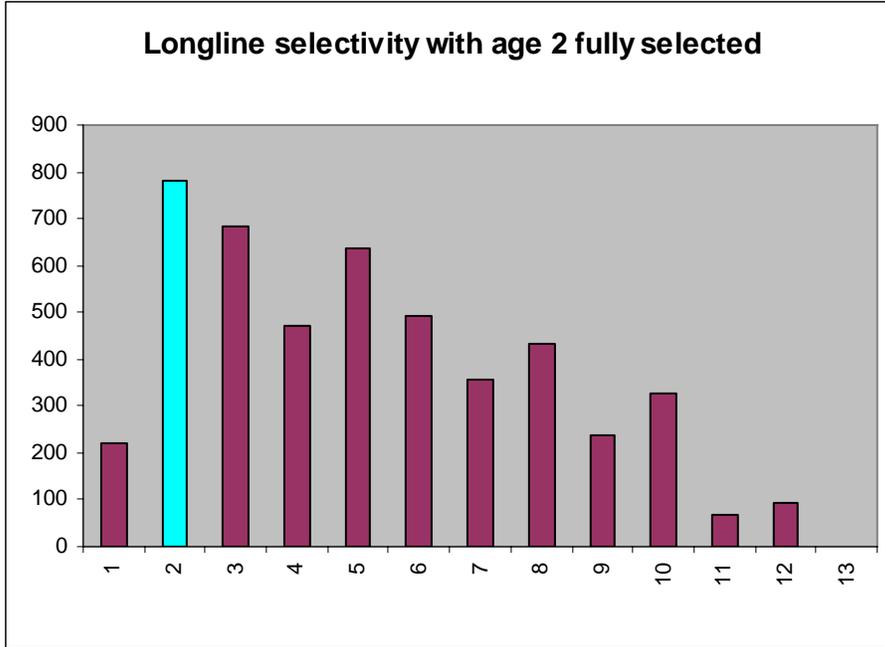
Longline selectivity with age 2 fully selected

Figure 8. Combined age frequencies of longline or "longline-like" selectivities for blacknose that are fully selected at age 2. (N = 4857)
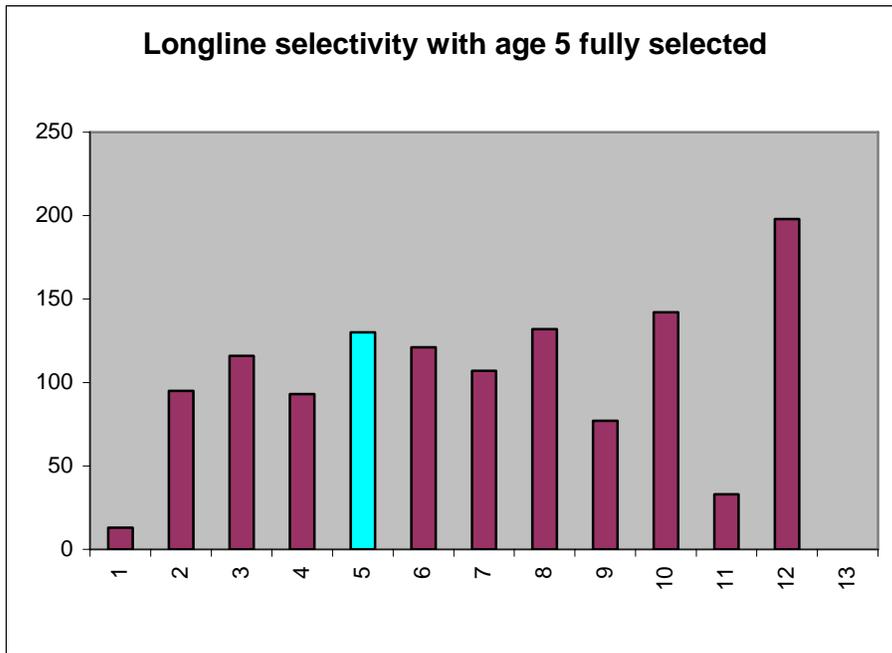
Longline selectivity with age 5 fully selected

Figure 9. Combined age frequencies of longline or "longline-like" selectivities for blacknose that are fully selected at age 5. (N = 1314)

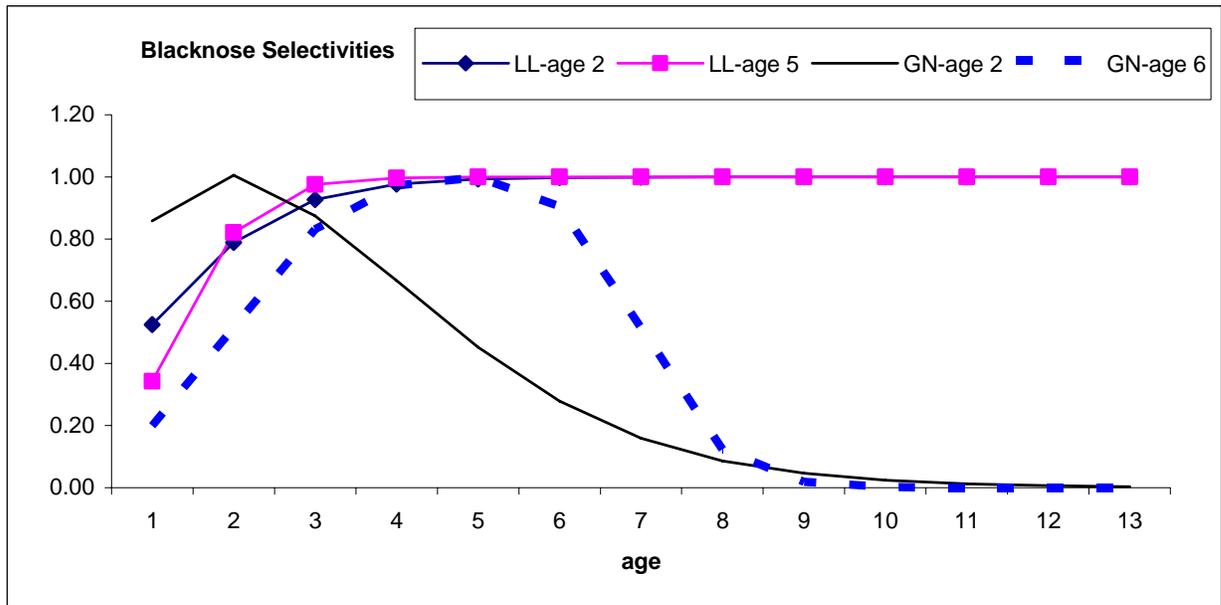This grouping resulted in the following selectivities (Figure 10):

Figure 10. The four selectivities used for blacknose shark in the 2007 small coastal shark assessment. The assessment document contains the parameters for each curve.

Bonnethead shark, *Sphyrna tiburo*

We found two unique selectivities based on eight age-frequency histograms. We grouped selectivities in the following manor:

Series	Fulcrum age	Type
PC GN	1	dome
DGNOP	2	dome
MML	2	dome
TX GN	1	dome
SC GN	2	dome
TX HL	1	dome
SEAMAP Fall and Summer Trawl GOM	1	dome
SEAMAP SA	2	dome

The age-frequencies were then grouped by combining all the individuals of the same age into selectivity-specific histograms (Figure 10-11).
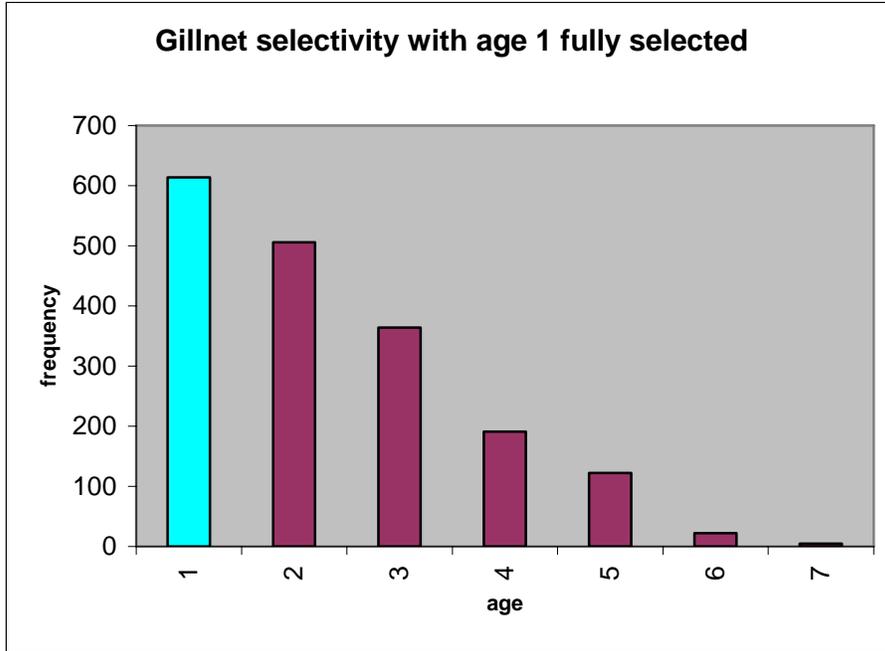
Gillnet selectivity with age 1 fully selected

Figure 11. Combined age frequencies of gillnet or "gillnet-like" selectivities for bonnethead that are fully selected at age 2. (N = 1210)

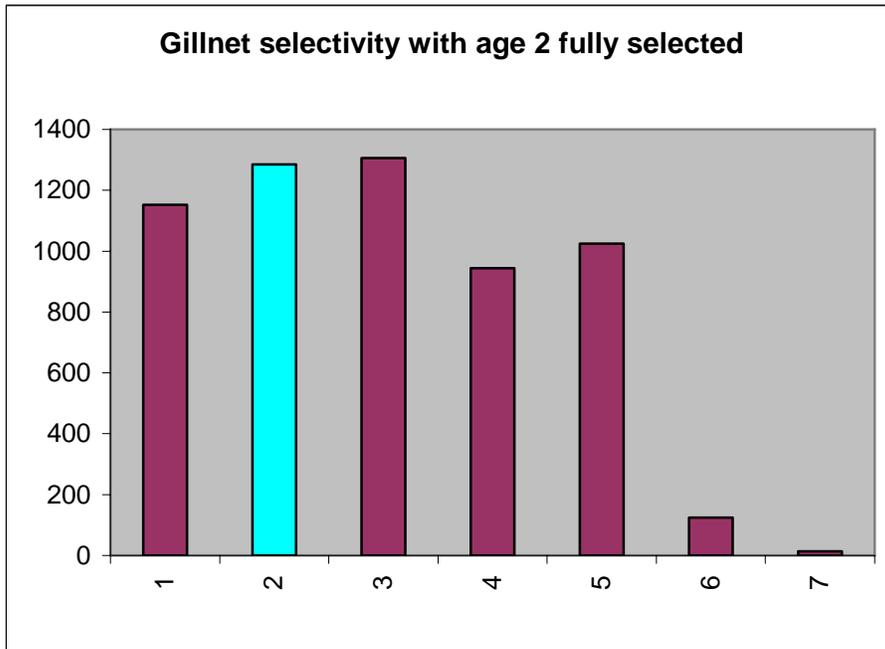**Gillnet selectivity with age 2 fully selected**

Figure 12. Combined age frequencies of gillnet or "gillnet-like" selectivities for bonnethead that are fully selected at age 2. (N = 5907)

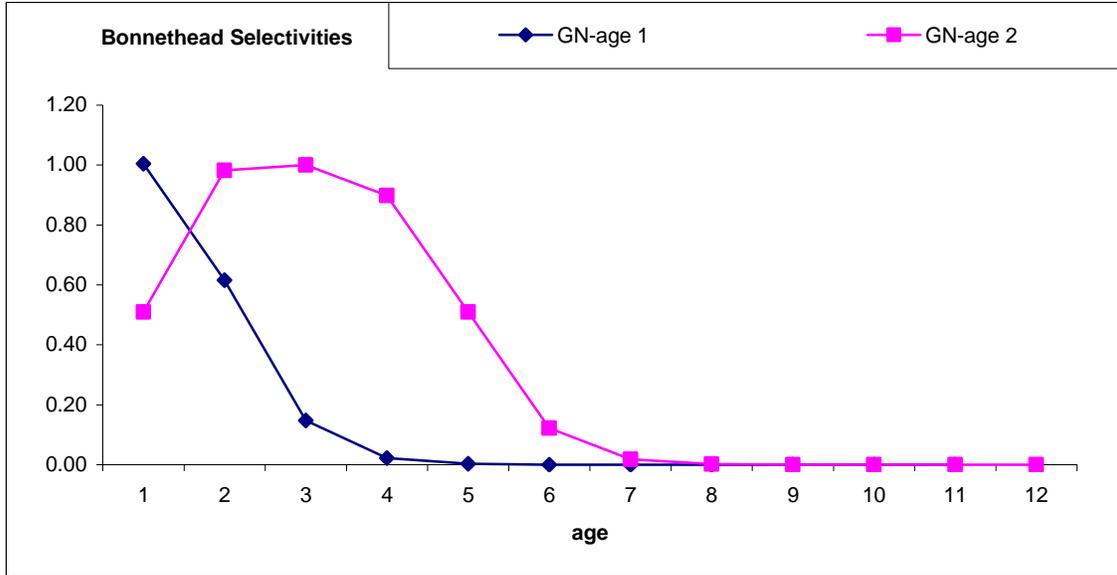This grouping resulted in the following selectivities (Figure 13):

Figure 13. The two selectivities used for bonnethead shark in the 2007 small coastal shark assessment. The assessment document contains the parameters for each curve.