SEDAR 2
Data Workshop

1. Data Collection and Processing of Data for Black Sea Bass Life History Studies

Sampling

Since 1979, black sea bass have been sampled with a variety of fishery-independent gear types from Cape Lookout, NC to Cape Canaveral, FL at depth ranging from 11 to 86 m (mean = 27 m). Specimens were collected primarily during May through August of each year. In addition, otoliths and gonads have been collected from black sea bass that were caught by commercial fishermen to help describe the maturity schedule. Fishery-independent data and fishery-dependent data are included on the CD in a file entitled "bsb05.mrg" and bsb50.mrg. Fishery-independent and fishery-dependent data can be separated by the project ID. PID = "105" for fishery-independent data and PID = "150" for fishery-dependent data.

Total length (cm), to the tip of the caudal fin filament, was recorded for all black sea bass collected during 1978-2001 for length frequency. Measurements of black sea bass used for life history studies included TL and SL (nearest mm) and weight to the nearest gram (g). Prior to 1986, all black sea bass caught at sea were retained for life history studies. During 1986-1993, up to 15 fish from each 20 mm SL size class and all fish less than 120 mm SL or greater than 265 mm SL were kept for life history studies during each year. Since 1994, up to 4 individuals from each 20 mm SL size class and all fish less than 120 mm SL and all fish greater than 265 mm SL were retained for life history studies for each cruise. Black sea bass landed by commercial fishers were also obtained, but only to help describe spawning seasonality and validate the periodicity of increments on otoliths.

Aging of Fish

Ages were determined for most specimens collected during 1978-1981. For fish collected during 1982-1998, common sizes were divided into 20-mm SL size classes and 16-26 individuals were randomly selected from each size class. Otoliths were examined from all individuals larger than 200 mm SL or smaller than 120 mm SL. About 400 fish were aged from each year for 1982-1998. The whole left sagitta was placed in water and examined for annuli (indicated by one translucent and one opaque zone) with transmitted light and a Nikon SMZ-2T dissecting microscope. Aging was done by two individuals, independently, without prior knowledge of the size of the fish or date of capture. If readers disagreed on the age after repeated readings, the fish was not included in analysis. Wenner et al. (1986) and Collins et al. (1996) validated the annual nature of increments on black sea bass otoliths from the SAB.

Table. Age frequency of black sea bass caught in Florida Trap, blackfish trap, chevron trap and hook and line gear.

AGE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	3	0.02	3	0.02
1	703	4.83	706	4.85
2	2740	18.84	3446	23.7
3	4706	32.36	8152	56.05
4	3853	26.49	12005	82.55
5	1671	11.49	13676	94.04
6	667	4.59	14343	98.62
7	144	0.99	14487	99.61
8	50	0.34	14537	99.96
9	6	0.04	14543	100

Mean	N	Std Dev	Std Error
3.4059	14543	1.2710333	0.0105397

Reproduction

The posterior portion of black sea bass gonads collected during 1978-1998 was removed, fixed in 10% seawater buffered formalin for 1-6 weeks then transferred to 50% isopropanol for 1-2 weeks. Gonads were processed, vacuum infiltrated, and blocked in paraffin. Three transverse sections (6-8 μ thick) were cut from each gonad with a rotary microtome, mounted on glass slides, stained with double-strength Gill haematoxylin, and counter-stained with eosin-y. Sex and reproductive condition were assessed according to histological criteria for fish collected during 1978-1998. Specimens with developing, ripe, spent or resting gonads were considered sexually mature. Mature females included individuals with oocyte development at or beyond the cortical granule (alveoli) stage and fish with beta, gamma, or delta stages of atresia. Sex and maturity were determined for 24,613 fish that were caught with Florida trap, blackfish trap, chevron trap and hook and line gear.

Description of Black Sea Bass Age, Growth, and Reproduction Data Set

Included on CD, is a data set in ASCI "bsb05.mrg" that has fishery independent data and the data set "bsb50.mrg" that has fishery dependent data. The layout for the data is as follows and can be found in file entitled "sizemat.sas":

```
DATA ONE; INFILE 'C:\BSB\BSB05.MRG' LRECL = 421;
INPUT PID 1-3 COLLNO 6-9 YR 4-5 GEAR 10-12 SPECIES $13-16 SPECNO 17-19
AGE 60-61 TL 72-75 SL 80-83 SEX 95 MAT $96 LAT 103-107 DEPTH 113-115;
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A description of these data elements follows:
PID = Project identity. "105" - fishery-independent MARMAP data and "150" – fishery dependent data collected by MARMAP.
COLLNO = Collection Number
GEAR = Gear Code (See Table 1).
SPECIES = Species Code. The species code for red porgy is "A272".
SPECNO = Specimen number.
AGE = Age
TL = Total length
FL = Fork Length
SL = Standard length
SEX = Sex (See Table 2). A sex code of 5 and mat = 6 is a transitional individual. Juveniles undergoing transition are 8A.
MAT = Maturity (Table 3).
DAY = Day
MO = Month
YEAR = Year
LAT = Latitude
LONG = Longitude
DEPTH = Depth in meters

Table 1. Gear codes for gear used by MARMAP during reef fish cruises.

014 HOOK AND LINE – Personal
022 ¾ YANKEE TRAWL
041 MINI ANTILLEAN S-TRAP - BAITED
043 SNAPPER REEL, ELECTRIC OR MANUAL, 2 HOOKS
052 MINI ANTILLEAN S-TRAP - UNBAITED
053 BLACKFISH TRAP - BAITED
054 BLACKFISH TRAP - UNBAITED
055 EXPERIMENTAL LARVAL TRAP
056 MINNOW TRAP - COVERED
057 MINNOW TRAP - UNCOVERED
059 FINE MESH TRAP
060 CUBIAN TRAPEZE - 1 X 2M .947MM MESH
061 VERTICAL LONG LINE
073 EXPERIMENTAL TRAP
074 FLORIDA "ANTILLEAN" TRAP
086 KALI POLE STANDARD (MARMAP)
087 BOTTOM LONGLINE
296 25 MM DIA. FILTER
297 THERMISTOR
298 CTD
299 SURFACE HYDRO SAMPLE
300 NISKIN BOTTLES - STANDARD CAST
301 NISKIN BOTTLES - SURFACE AND BOTTOM
305 XBT
324 CHEVRON TRAP (MARMAP)
501 BOTTOM TRIPOD FIXED TV
502 STAT. TV STATION - HORIZONTAL
503 STAT. TV STATION - VERTICAL
504 DRIFT TV TRANSECT - HORIZONTAL
505 DRIFT TV TRANSECT - VERTICAL
506 TOWED TV TRANSECT - HORIZONTAL
507 TOWED TV TRANSECT - VERTICAL
513 PAN & TILT TV

Table 2. Sex codes (After Waltz et al. 1979). Revised June 1997.

Code	
0	Undifferentiated. Germ cells not yet developing.
1	Gonad entirely testicular (Triangular in cross-section).
2	Gonad entirely ovarian (Round or oval in cross-section).
3	Hermaphrodite (simultaneous). Testicular and ovarian tissue at the same maturity stage.
4	Hermaphroditic male. Gonad functionally testicular with some traces of ovarian tissue.
5	Hermaphroditic female. Gonad functionally ovarian with some traces of testicular tissue.
6	Ovarian tissue, but ovary wall not present in sufficient quantity to determine presence or absence of testicular tissue.
7	Testicular tissue, but insufficient quantity to determine presence or absence of ovarian tissue.
8	Immature ovarian tissue undergoing sexual transition. Used only in combination with reproductive state code = A (see P. pagrus).
9	Unknown.

Table 1. Histological criteria used to determine reproductive state in black sea bass *Centropristis striata* from Hastings, 1981; Wallace and Selman, 1981; Hunter et al. 1986.

Reproductive state	Male	Female
Immature (virgin)	Small transverse section compared to resting male. Spermatogonia present but little or no spermatocyte development.	Previtellogenic oocytes only; no evidence of atresia. In comparison to resting female, most previtellogenic oocytes < 80 μm diameter, area of transverse section of ovary is smaller, lamellae lack muscle and connective tissue bundles, lamellae are not as elongate, oogonia more abundant along the margin of lamellae,ovarian wall is thinner.
Developing	Development of cysts containing primary and secondary spermatocytes through some accumulation of spermatozoa in lobular lumina and collecting sinuses near ovarian wall.	Oocytes undergoing cortical granule (alveoli) formation through nucleus migration and partial coalescence of yolk globules.
Running ripe	Predominance of spermatozoa in lobules and collecting sinuses. Little or no occurrence of spermatogenesis.	Completion of yolk coalescence and hydration in the most advanced oocytes. Zona radiata becomes thin. Postovulatory follicles sometimes present.
Developing, recent spawn	Not assessed.	Developing stage as described above plus presence of postovulatory follicles.
Spent	No spermatogenesis. Some residual spermatozoa in lobules and collecting sinuses.	More than 50% of vitellogenic oocytes in alpha or beta stage of atresia.
Resting	Little or no spermatocyte development. Empty lobules and sinuses evident.	Perinuclear oocytes only; traces of atresia. In comparison to immature female, most previtellogenic oocytes > 80 μm in diameter, area of transverse section of ovary is larger, lamellae have muscle and connective tissue bundles, lamellae are more elongate and convoluted, oogonia less abundant along margin of lamellae, ovarian wall is thicker.
Mature specimen, state unknown	Mature, but inadequate quantity of tissue or postmortem histolysis prevent further assessment of reproductive state	Mature, but inadequate quantity of tissue or postmortem histolysis prevent further assessment of reproductive state.
Simultaneous	Presence of distinct ovarian and testicular regions in approximately equal amounts and of the same reproductive state (usually inactive). This gonad structure was observed infrequently.	
Transitional	Proliferation of active testicular tissue (spermatogonia through spermatozoa) within alamellar regions along the inner surface of the ovarian wall in spent or resting ovary.	

2. Collection and Processing of Data for Vermilion Snapper Life History Studies

Sampling

Since 1977, vermilion snapper have been sampled with a variety of fishery-independent gear types from Cape Lookout, NC to Cape Canaveral, FL at depth ranging from 14 to 100 m (mean = 40 m). Specimens were collected primarily during May through August of each year. In addition, otoliths and gonads have been collected from vermilion snapper that were caught by commercial fishermen to estimate fecundity and to verify that increment formation is annual.

Fork length (cm) was recorded for all vermilion snapper collected during 1977-2001 for length frequency. Measurements of vermilion snapper used for life history studies included TL, FL and SL (nearest mm) and weight to the nearest gram (g). Prior to 1986, all vermilion snapper caught at sea were retained for life history studies. During 1986-1993, up to 15 fish from each 1 cm FL size class.

Aging of Fish

Ages were determined for most specimens collected during 1979-2001 (n = 2,891). None of the fish collected during 1994-1998 have been aged. Transverse sections of the left sagitta were examined for annuli (indicated by one translucent and one opaque zone) with transmitted light and a Nikon SMZ-2T dissecting microscope. Aging was done by two individuals, independently, without prior knowledge of the size of the fish or date of capture. If readers disagreed on the age after repeated readings, the fish was not included in analysis. That the increments are annuli was validated by Zhao et al. (1997).

Processing of gonad samples

The posterior portion of vermilion snapper gonads (except males in 1993-2000) collected during 1987-2001 (n = 4276) was removed, fixed in 10% seawater buffered formalin for 1-6 weeks then transferred to 50% isopropanol for 1-2 weeks. Gonads were processed, vacuum infiltrated, and blocked in paraffin. Three transverse sections (6-8 μ thick) were cut from each gonad with a rotary microtome, mounted on glass slides, stained with double-strength Gill haematoxylin, and counter-stained with eosin-y. Sex and reproductive condition were assessed according to histological criteria. Specimens with developing, ripe, spent or resting gonads were considered sexually mature. Mature females included individuals with oocyte development at or beyond the cortical granule (alveoli) stage and fish with beta, gamma, or delta stages of atresia.

Sex and reproductive state were assessed macroscopically during 1977-86 (n = 5233). During 1993-2000, sex only was assessed macroscopically for males.

Description of vermilion snapper age, growth, and reproduction data set

The layout of the data file (merge2.txt) is as follows and can be found in the SAS programs:

```
filename datain 'c:\dbase\vermilion\merge2.txt';
data one;
  infile datain  missover pad lrecl=130;
  input projid  collno  gear  spcode $  specno  tl  fl  sl  fishwt
     month  lat  long  duration  age  bumpage  sex  mat $;
```

A description of these data elements follows:
PROJID = Project identity. “105” - fishery-independent MARMAP data
COLLNO = Collection Number
GEAR = Gear Code (See Table 1).
SPCODE = Species Code. The species code for vermilion snapper is “A252”.
SPECNO = Specimen number.
TL = Total length (mm)

FL = Fork Length (mm)
SL = Standard length (mm)
FISHWT = Whole fish weight (g)
MONTH = Month
LAT = Latitude
LONG = Longitude
DURATION = duration of gear deployment (minutes)
AGE = Age
BUMPAGE = Age after assignment to year class
SEX = Sex (See Table 2).
MAT = Maturity (Table 3 in separate file).

Analysis

Size and age at maturity of males and females (Sex codes = 1, 2):

Raw data file: merge2.txt
Program files: agemat.sas, sizemat.sas
Summary file: maturitysummary.xls
EXCEL files: agemat.xls, sizemat.xls

Immature: reproductive stage = 1
Mature: reproductive stage = 2, 3, 4, 5, 7, 8, B, C, D, E, F, G
Eliminated reproductive stage = 0, 9
Codes for gear, sex, and reproductive stage are defined in Tables 1, 2, and 3 (Table 3 in separate file).

All data are from fishery-independent sampling by MARMAP program. Trawl data were restricted to the months of the spawning season (May - Sep).
1977-1986: macroscopic assessment of sex and reproductive stage
1987- present: histological assessment of sex and reproductive stage with exception of male vermilion snapper (macroscopic assessment of sex only during 1993-2000).

Summary and Recommendation: Gear and period specific maturity curves should be used given the plasticity exhibited over time in trawl data (see agemat.xls and sizemat.xls). Maturity curves were not generated for hook-and-line and traps because those gear types caught very few immature fish (see maturitysummary.xls).

Sex ratio (Sex codes = 1, 2):

Raw data file: merge2.txt
Program files: sexratioage.sas, sexratiolength20.sas
Summary file: sexratiosummary.xls
EXCEL files: sexratiolengthage.xls, sexratio gear vs. size.xls

All specimens with a sex code were included. No reproductive stages were eliminated because doing so would remove from the data set all males collected by MARMAP during 1993-2000, years during which sex was assessed macroscopically for males; therefore, the data set analyzed included immature and mature specimens.

Codes for gear, sex, and reproductive stage are defined in Tables 1, 2, and 3 (Table 3 in separate file).
.
All data are from fishery-independent sampling by MARMAP program.
1977-1986: macroscopic assessment of sex and reproductive stage

1987- present: histological assessment of sex and reproductive stage with exception of male vermilion snapper (macroscopic assessment of sex only during 1993-2000).

Summary and Recommendation: A high degree of consistency in sex ratio over time was noted for each gear type (see sexratiosummary.xls). The lower percentage of females in trawl samples is probably due to the difference in length frequency distributions among gear types (see sexratio gear vs. size.xls). The trawls caught smaller specimens than did hook-and-line-and traps. Data from hook-and-line and traps is viewed as more representative of the population. A percentage of females between 60-70% is consistent with the results of studies done in the 1970s (Grimes and Huntsman, 1980) and 1990s (Cuellar et al., 1996)

Annual fecundity:

Information on the relationship between annual fecundity and age is not available. Regression equations relating batch fecundity to fork length and ovary-free body weight are available in Cuellar et al. (1996) and stated below. **Note** that the range of length (180-330 mm FL) and weight (100-700 g) represented by the equations is rather narrow. Multiplying batch fecundity estimates by 35 (the no. of spawning events per spawning season) will produce estimates of annual fecundity.

Batch fecundity = $0.0438*\text{Fork Length}^{2.508}$; $r^2 = 0.44$, n = 49, length in mm

Batch fecundity = 14,037 + (112*Ovary-free weight); $r^2 = 0.33$, n = 49, weight in grams

Conversion to TL: TL = 1.107792*FL + 1.093169; $r^2 = 0.99$, n = 2287, range of TL = 118-560 mm

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Table 1. Gear codes for gear used by MARMAP during reef fish cruises.

014 HOOK AND LINE – Personal
022 ¾ YANKEE TRAWL
041 MINI ANTILLEAN S-TRAP - BAITED
043 SNAPPER REEL, ELECTRIC OR MANUAL, 2 HOOKS
052 MINI ANTILLEAN S-TRAP - UNBAITED
053 BLACKFISH TRAP - BAITED
054 BLACKFISH TRAP - UNBAITED
055 EXPERIMENTAL LARVAL TRAP
056 MINNOW TRAP - COVERED
057 MINNOW TRAP - UNCOVERED
059 FINE MESH TRAP
060 CUBIAN TRAPEZE - 1 X 2M .947MM MESH
061 VERTICAL LONG LINE
070 Trawl - 40/54 fly net
073 EXPERIMENTAL TRAP
074 FLORIDA "ANTILLEAN" TRAP
086 KALI POLE STANDARD (MARMAP)
087 BOTTOM LONGLINE
296 25 MM DIA. FILTER
297 THERMISTOR
298 CTD
299 SURFACE HYDRO SAMPLE
300 NISKIN BOTTLES - STANDARD CAST
301 NISKIN BOTTLES - SURFACE AND BOTTOM

305 XBT
324 CHEVRON TRAP (MARMAP)
501 BOTTOM TRIPOD FIXED TV
502 STAT. TV STATION - HORIZONTAL
503 STAT. TV STATION - VERTICAL
504 DRIFT TV TRANSECT - HORIZONTAL
505 DRIFT TV TRANSECT - VERTICAL
506 TOWED TV TRANSECT - HORIZONTAL
507 TOWED TV TRANSECT - VERTICAL
513 PAN & TILT TV

Table 2. Sex codes (After Waltz et al. 1979). Revised June 1997.

Code	
0	Undifferentiated. Germ cells not yet developing.
1	Gonad entirely testicular (Triangular in cross-section).
2	Gonad entirely ovarian (Round or oval in cross-section).
3	Hermaphrodite (simultaneous). Testicular and ovarian tissue at the same maturity stage.
4	Hermaphroditic male. Gonad functionally testicular with some traces of ovarian tissue.
5	Hermaphroditic female. Gonad functionally ovarian with some traces of testicular tissue.
6	Ovarian tissue, but ovary wall not present in sufficient quantity to determine presence or absence of testicular tissue.
7	Testicular tissue, but insufficient quantity to determine presence or absence of ovarian tissue.
8	Immature ovarian tissue undergoing sexual transition. Used only in combination with reproductive state code = A (see P. pagrus).
9	UnknownLiterature cited

Literature cited

Cuellar, N.C., G.R. Sedberry, and D.M. Wyanski. 1996. Reproductive seasonality, maturation, fecundity, and spawning frequency of the vermilion snapper, *Rhomboplites aurorubens*, off the southeastern United States. Fish. Bull. 94:635-653.

Grimes, C.B., and G.R. Huntsman. 1980. Reproductive biology of the vermilion snapper, *Rhomboplites aurorubens*, from North Carolina and South Carolina. Fish. Bull. 78:137-146.

Zhao, B., J.C. McGovern, and P.J. Harris. 1997. Age, growth, and temporal change in size at age of the vermilion snapper from the South Atlantic Bight. Trans. Amer. Fish. Soc. 126:181-193.

Summarized by J.C. McGovern and D.M. Wyanski
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