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# **SENSORY CHARACTERISTICS OF CULTURED HYBRID STRIPED BASS DURING FROZEN STORAGE**

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## **Abstract**

Sensory analysis was used to compare flavor and texture characteristics of cultured hybrid striped bass prepared as either vacuum packaged skinless fillets, vacuum packaged headed and gutted (H&G) hybrids, or glazed skinless fillets and glazed H&G hybrids packed in waxed cartons, during 12 months of storage at -20°C. The skinless fillets and H&G hybrids retained their initial flavor characteristics for approximately 4-6 months and for at least 10 months of frozen storage, respectively. Product form, not packaging method, had the most effect on sensory characteristics of hybrid striped bass following extended frozen storage. The skinless fillets became less moist, more sour, more rancid and more yellow than the H&G hybrids. This was probably due to their greater exposed surface areas. All samples became harder, chewier and more flaky during frozen storage, but unlike flavor characteristics, texture differences between skinless fillets and H&G hybrids were less discernable.

## Introduction

Personnel at the South Carolina Marine Resource Research Institute (SCMRRRI) have conducted research on pond culture of hybrid striped bass (Morone saxatilis x Morone chrysops). They have been able to produce, under intensive management, approximately 7400 pounds of hybrids per acre in 18 months (personal communication, T.S. Smith, 1987). Our laboratory has conducted research on the proximate composition, sensory characteristics and shelflife of these hybrids during iced storage (Jahncke et al., 1988). There is no information, however, on the changes in sensory characteristics occurring in cultured hybrid striped bass during frozen storage. Therefore, the objectives of this study were to determine the effect of 12 months of storage at -20°C on the sensory characteristics of: (1) vacuum packaged skinless fillets, (2) glazed skinless fillets packed in waxed cartons, (3) vacuum packaged headed and gutted (H&G) hybrids and (4) glazed H&G hybrids packed in waxed cartons.

## Materials and Methods

### Collection of Samples

The fish used in this study were cultured in ponds at the Waddell Mariculture Center near Bluffton, SC. The fish averaged 36.0 cm in fork length (FL) and 765 g in weight. The fish, which were immediately iced after harvesting, were processed commercially and transported to the National Marine Fisheries Service Laboratory in Charleston, SC.

### Preparation and Storage of Samples

Fifty cultured hybrid striped bass were divided into four treatments consisting of: (1) vacuum packaged skinless fillets, (2) glazed skinless fillets

packed in waxed cartons, (3) vacuum packaged H&G hybrids and (4) glazed H&G hybrids packed in waxed cartons.

The skinless fillets and H&G hybrids were rinsed with clean water before packaging. Vacuum packaged fish were sealed in Cryovac B620 Barrier Bags (Cryovac Div. W.R. Grace & Co., Duncan, SC)<sup>1</sup> using a multivac 500 vacuum packaging machine (Multivac Sepp Haggenmüller KG, West Germany)<sup>1</sup>. Five pound capacity waxed cartons were used to store the glazed skinless fillets and glazed H&G hybrids. All treatments were initially frozen in a -40°C storage freezer for 24 hours and then moved into a second storage freezer at -20°C. Samples were selected for evaluation every two months over a 12 month period.

#### Sensory Evaluation

Prior to analysis, the fillets and H&G hybrids were thawed overnight in a refrigerated room (+3°C). The H&G fish were filleted before analysis. All fillets (n = 4 fillets/treatment) were trimmed, removing belly flap, nape and tail section, rinsed and randomly placed into boil-in bags containing drainage pockets. The bags were suspended in a water bath at 71°C. Thermocouples were placed in the thickest part of the fillet, and fillets were cooked to an internal temperature of 71°C. A six member trained sensory panel determined the flavor and texture characteristics of the fillets.

The panelists were trained using several species of marine fish as standards according to the flavor and texture method of Kapsalis and Maller (1980). The cooked fillets were placed into pre-heated, coded, covered dishes (ca. 30 g

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<sup>1</sup>The use of trade names or products does not imply endorsement by the National Marine Fisheries Service, NOAA.

sample). Panelists were seated in individual booths, supplied with a flavor and texture reference key, water and score sheets. The coded samples were evaluated using a modification of Quantitative Descriptive Analysis (QDA) (Stone et al., 1974). Flavor characteristics were evaluated using a 15 cm line scale having a vertical line at the extreme left end and a second vertical line 1 cm from the right end. The scale ran from absent to strong for total intensity of odor (TIO), total intensity of flavor (TIF), sweetness, sourness, earthiness, rancidity, salty-briny and shellfish flavors. The texture line scale had a vertical line 1 cm from the left end and a second vertical line 1 cm from the right end. Characteristics evaluated were color (white to dark), hardness (soft to firm), flakiness (slight to very flaky), chewiness (slight to very chewy), fibrousness (slight to very fibrous) and moistness (slight to very moist). Trained panelists marked the scale with a vertical line at the perceived intensity of the attribute. The scores were determined by measuring the distance of the vertical line, to the nearest 0.1 cm, from the extreme left end of the 15 cm line scale. Results were not discussed with the panelists.

#### Thiobarbituric Acid Determination (TBA)

Duplicate TBA analyses were conducted on raw fillet samples, by the distillation method of Tarladgis et al. (1960), as described in Woyewoda et al. (1986). Approximately 15 g of flesh were removed from both ends of each of four raw fillets selected for sensory analysis. The flesh (ca. 60 g) was homogenized before duplicate 10 g samples were removed for analysis.

#### Statistical Evaluation

Statistical Analysis System (SAS Institute Inc., Cary, NC) was used to do a two way analysis of variance on the results. When the F test was found to be

significant, differences between treatment means were determined using Fisher's LSD Test (SAS Institute Inc., Cary, NC).

### Results and Discussion

Tables 1-4 show changes in flavor and texture characteristics of hybrid striped bass during 12 months of frozen storage at  $-20^{\circ}\text{C}$ . Initially the cooked flesh had a mild total intensity of odor (TIO) and total intensity of flavor (TIF) with moderate sweetness. The flesh had no shellfish flavor, but the dark flesh had a slight earthy flavor. The flesh was also moderately flaky, slightly fibrous, moist, soft and easy to chew.

#### Flavor

Table 1 indicates that at 12 months of frozen storage, TIO scores for vacuum packaged skinless fillets (VF) increased significantly ( $P < 0.05$ ). TIF scores increased significantly at ten months of storage ( $P < 0.05$ ). In comparison, Table 2 shows a significant increase in TIO at ten months and TIF at six months for glazed and boxed skinless fillets (GF) ( $P < 0.05$ ). There were no significant TIO or TIF differences between VF and GF ( $P > 0.05$ ).

Table 3 indicates that at twelve months of storage, TIO but not TIF, increased significantly for vacuum packaged H&G hybrids (VHG) ( $P < 0.05$ ). In addition, there were no significant overall changes in TIO or TIF scores, for glazed and boxed H&G hybrids (GHG), during the 12 months of frozen storage ( $P > 0.05$ ) (Table 4). Similar to the skinless fillets, there were no significant TIO or TIF differences between VHG and GHG ( $P > 0.05$ ).

Sensory sweetness scores, on the other hand, decreased significantly at two months of storage for VF and GF ( $P < 0.05$ ) (Tables 1 and 2). Sweetness scores for VHG and GHG also decreased, but not significantly ( $P > 0.05$ ) (Tables 3 and

4). At two months of storage, and for the remainder of the study there were no longer any significant sweetness score differences between skinless fillets and H&G hybrids ( $P > 0.05$ ). A decrease in seafood sweetness during storage has been attributed to nucleotide degradation (Bremner et al., 1988; Ikeda, 1980). Sourness scores, on the other hand, increased significantly at 12 months of storage for VF and GF ( $P < 0.05$ ) (Tables 1 and 2). There were no significant increases in sourness scores for VHG and GHG ( $P > 0.05$ ) (Tables 3 and 4).

Earthiness and rancidity attributes were primarily associated with the dark flesh of the lateral line. This seems reasonable, since the red muscle fibers have been shown to contain more lipid and heme compounds than the white muscle fibers (George, 1962; Thurston and MacMaster, 1960). There were no significant differences or changes in earthiness scores in VF, GF, VHG or GHG during frozen storage ( $P > 0.05$ ) (Tables 1-4). There was, at ten months of storage, however, a significant increase in sensory rancidity scores for VF and GF ( $P < 0.05$ ) (Tables 1 and 2), but not for VHG and GHG ( $P > 0.05$ ) (Tables 3 and 4). The decrease in sensory rancidity scores for GF at 12 months of storage, is unexplained, but may have been the result of panelists evaluating fillets containing less dark lateral line flesh (Table 2). Similarly, TBA values, for the period from 4-12 months of storage, were also higher for VF and GF compared with VHG and GHG (Table 5). TBA values for VF and GF were still less than 6.0  $\mu\text{moles/kg}$ , however. The decrease in TBA values for VF, GF, VHG and GHG after four months of storage is not unusual, since thiobarbituric substances may interact with substances such as proteins, cysteine and/or methionine and become partially unavailable for the TBA test (Buttkus 1967, 1969).



### Texture

Texture characteristics changed during frozen storage, but there were no significant differences in hardness, flakiness, chewiness, fibrousness and moistness scores between skinless fillets and H&G hybrids ( $P > 0.05$ ).

The surface of cooked VF and GF was rated as being significantly darker than VHG and GHG (more yellow) at 12 months of storage ( $P < 0.05$ ) (Tables 1-4). This may have been due to lipid oxidation, and/or polymerization and formation of lipoprotein complexes (Porkorny et al., 1974; Shenouda, 1980). Although scores varied, the surface of cooked VHG and GHG did not change significantly in color during 12 months of storage ( $P > 0.05$ ) (Tables 3 and 4). VF, GF and GHG began to show an increasing trend in their hardness scores beginning at six months of storage (Tables 1, 2 and 4). This occurred at approximately 10 months of storage for VHG (Table 3). VF and GHG were found to be significantly chewier at ten and 12 months of storage, respectively ( $P < 0.05$ ) (Tables 1 and 4). GF and VHG showed more of an increasing trend in chewiness scores beginning at ten months of storage (Tables 2 and 3). VF and GF were rated as being significantly more flaky at ten months of storage ( $P < 0.05$ ) (Tables 1 and 2). VHG and GHG were significantly more flaky at ten and 12 months than they were initially, or at two and four months of frozen storage ( $P < 0.05$ ) (Tables 3 and 4). Fibrousness scores also increased for all treatments, but not significantly ( $P > 0.05$ ) (Tables 1-4).

Moistness scores for VF and GF decreased significantly at two months of storage ( $P < 0.05$ ), and then leveled off for the remainder of the study (Tables 1 and 2). Moistness scores for VHG and GHG also decreased, but the overall decrease was not statistically significant ( $P > 0.05$ ) (Tables 3 and 4). The

significant decrease in moistness scores for VHG at four and six months, and GHG at four months of storage ( $P < 0.05$ ) is unexplained, but may have been due to overcooking.

### **Conclusions**

The skinless fillets and H&G hybrids retained their initial flavor characteristics for approximately 4-6 months and for at least 10 months of frozen storage, respectively. Product form had more effect on sensory characteristics of frozen hybrid striped bass than did the packaging method. The more rapid changes in flavor characteristics of skinless fillets compared with the H&G hybrids can probably be attributed to their greater surface area. The increased surface area could also account for the skinless fillets becoming less moist, more sour, more rancid and more yellow than the H&G hybrids during frozen storage.

All hybrid samples became harder, chewier and more flaky during frozen storage. Unlike flavor characteristics, texture differences between skinless fillets and H&G hybrids were less discernable.

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Table 1. Sensory Ratings of Cooked Fillets Prepared from Vacuum Packaged Skinless Fillets (VF)  
(Mean  $\pm$  S.D.; 15 cm Line Scale) <sup>1/</sup>

Months of Storage at -20°C						
	0	2	4	6	10	12
TIO <sub>2</sub> <sup>2/</sup>	2.2 $\pm$ 1.0 <sup>a</sup>	2.9 $\pm$ 1.8 <sup>ab</sup>	3.2 $\pm$ 0.4 <sup>ab</sup>	4.0 $\pm$ 1.4 <sup>bd</sup>	4.5 $\pm$ 1.6 <sup>d</sup>	6.7 $\pm$ 1.9 <sup>c</sup>
TIF <sub>3</sub> <sup>3/</sup>	4.5 $\pm$ 1.0 <sup>a</sup>	3.9 $\pm$ 1.6 <sup>a</sup>	3.2 $\pm$ 1.0 <sup>a</sup>	5.9 $\pm$ 2.6 <sup>a</sup>	6.7 $\pm$ 1.9 <sup>b</sup>	7.8 $\pm$ 1.2 <sup>b</sup>
Sweetness	3.7 $\pm$ 1.5 <sup>a</sup>	2.5 $\pm$ 1.4 <sup>b</sup>	1.6 $\pm$ 0.6 <sup>bc</sup>	2.6 $\pm$ 1.6 <sup>b</sup>	1.8 $\pm$ 1.3 <sup>bc</sup>	0.9 $\pm$ 1.0 <sup>c</sup>
Sourness	0.3 $\pm$ 0.4 <sup>a</sup>	0.6 $\pm$ 0.6 <sup>ab</sup>	0.6 $\pm$ 0.7 <sup>ab</sup>	0.3 $\pm$ 0.4 <sup>a</sup>	1.1 $\pm$ 0.7 <sup>b</sup>	2.3 $\pm$ 0.8 <sup>c</sup>
Earthiness	1.4 $\pm$ 1.5	1.3 $\pm$ 1.7	0.7 $\pm$ 0.8	1.4 $\pm$ 0.8	1.1 $\pm$ 1.6	0.8 $\pm$ 0.9
Rancidity	0.2 $\pm$ 0.6 <sup>a</sup>	0.2 $\pm$ 0.6 <sup>a</sup>	0.2 $\pm$ 0.4 <sup>a</sup>	0.5 $\pm$ 1.0 <sup>a</sup>	2.2 $\pm$ 2.1 <sup>b</sup>	1.6 $\pm$ 1.4 <sup>b</sup>
Salty-briny	1.8 $\pm$ 0.7	1.4 $\pm$ 1.1	0.9 $\pm$ 0.7	2.1 $\pm$ 1.8	- -	1.2 $\pm$ 0.9
Shellfish	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0
Color	6.5 $\pm$ 1.1 <sup>a</sup>	5.7 $\pm$ 1.2 <sup>a</sup>	5.6 $\pm$ 1.0 <sup>a</sup>	5.4 $\pm$ 1.9 <sup>a</sup>	6.6 $\pm$ 0.8 <sup>a</sup>	9.4 $\pm$ 0.5 <sup>b</sup>
Hardness	4.6 $\pm$ 2.1 <sup>ab</sup>	3.5 $\pm$ 1.5 <sup>a</sup>	4.8 $\pm$ 1.9 <sup>ab</sup>	5.6 $\pm$ 0.9 <sup>bc</sup>	7.8 $\pm$ 2.0 <sup>c</sup>	7.5 $\pm$ 1.8 <sup>c</sup>
Flakiness	5.5 $\pm$ 1.8 <sup>a</sup>	6.4 $\pm$ 2.2 <sup>a</sup>	4.5 $\pm$ 1.6 <sup>a</sup>	6.3 $\pm$ 0.2 <sup>a</sup>	8.4 $\pm$ 2.8 <sup>b</sup>	7.6 $\pm$ 2.6 <sup>b</sup>
Chewiness	3.4 $\pm$ 1.6 <sup>a</sup>	3.4 $\pm$ 1.4 <sup>a</sup>	4.4 $\pm$ 1.8 <sup>a</sup>	5.2 $\pm$ 1.0 <sup>a</sup>	7.6 $\pm$ 1.6 <sup>b</sup>	7.1 $\pm$ 1.6 <sup>b</sup>
Fibrousness	3.0 $\pm$ 1.3	4.2 $\pm$ 1.7	4.5 $\pm$ 1.1	4.0 $\pm$ 2.0	5.4 $\pm$ 2.2	5.5 $\pm$ 2.0
Moistness	9.0 $\pm$ 1.2 <sup>a</sup>	6.0 $\pm$ 1.7 <sup>b</sup>	5.1 $\pm$ 0.2 <sup>b</sup>	5.5 $\pm$ 1.8 <sup>b</sup>	5.4 $\pm$ 1.3 <sup>b</sup>	5.2 $\pm$ 0.8 <sup>b</sup>

<sup>1/</sup> n=6 panelists, mean scores within the same row with the same or without any superscripts are not statistically different (P > 0.05).

<sup>2/</sup> Total Intensity of Odor

<sup>3/</sup> Total Intensity of Flavor

Table 2. Sensory Ratings of Cooked Fillets Prepared from Glazed and Boxed Skinless Fillets (GF)  
(Mean  $\pm$  S.D.; 15 cm Line Scale)<sup>1/</sup>

	Months of Storage at -20°C					
	0	2	4	6	10	12
TI0 <sup>2/</sup>	2.2 $\pm$ 1.0 <sup>a</sup>	2.9 $\pm$ 2.3 <sup>a</sup>	3.6 $\pm$ 1.0 <sup>a</sup>	3.6 $\pm$ 1.4 <sup>a</sup>	5.4 $\pm$ 1.7 <sup>b</sup>	5.5 $\pm$ 1.5 <sup>b</sup>
TIF <sup>3/</sup>	4.5 $\pm$ 1.0 <sup>a</sup>	5.1 $\pm$ 1.9 <sup>a</sup>	4.5 $\pm$ 1.5 <sup>a</sup>	6.5 $\pm$ 1.3 <sup>b</sup>	7.1 $\pm$ 1.6 <sup>b</sup>	6.2 $\pm$ 1.9 <sup>b</sup>
Sweetness	3.7 $\pm$ 1.5 <sup>a</sup>	2.5 $\pm$ 1.6 <sup>b</sup>	1.3 $\pm$ 1.1 <sup>b</sup>	1.8 $\pm$ 1.7 <sup>b</sup>	1.4 $\pm$ 1.2 <sup>b</sup>	1.6 $\pm$ 1.6 <sup>b</sup>
Sourness	0.3 $\pm$ 0.4 <sup>a</sup>	0.8 $\pm$ 0.6 <sup>ab</sup>	0.9 $\pm$ 1.3 <sup>ab</sup>	1.4 $\pm$ 0.6 <sup>b</sup>	1.0 $\pm$ 1.0 <sup>b</sup>	1.9 $\pm$ 1.1 <sup>c</sup>
Earthiness	1.4 $\pm$ 1.5	2.0 $\pm$ 2.1	0.8 $\pm$ 1.1	1.5 $\pm$ 0.9	1.5 $\pm$ 1.1	0.7 $\pm$ 0.8
Rancidity	0.2 $\pm$ 0.6 <sup>a</sup>	1.0 $\pm$ 1.1 <sup>a</sup>	0.7 $\pm$ 0.9 <sup>a</sup>	1.1 $\pm$ 1.3 <sup>a</sup>	2.1 $\pm$ 1.8 <sup>b</sup>	0.1 $\pm$ 0.3 <sup>a</sup>
Salty-briny	1.8 $\pm$ 0.7	1.4 $\pm$ 0.9	1.0 $\pm$ 0.8	2.1 $\pm$ 1.2	- -	1.3 $\pm$ 0.9
Shellfish	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0
Color	6.5 $\pm$ 1.1 <sup>ab</sup>	6.3 $\pm$ 0.7 <sup>ab</sup>	6.0 $\pm$ 2.0 <sup>b</sup>	6.8 $\pm$ 1.1 <sup>ab</sup>	7.6 $\pm$ 1.5 <sup>ac</sup>	8.5 $\pm$ 0.8 <sup>c</sup>
Hardness	4.6 $\pm$ 2.1 <sup>a</sup>	4.1 $\pm$ 1.2 <sup>a</sup>	4.7 $\pm$ 1.3 <sup>a</sup>	5.7 $\pm$ 0.5 <sup>ab</sup>	7.1 $\pm$ 1.9 <sup>bc</sup>	8.2 $\pm$ 1.4 <sup>c</sup>
Flakiness	5.5 $\pm$ 1.8 <sup>a</sup>	6.0 $\pm$ 2.3 <sup>a</sup>	4.6 $\pm$ 0.8 <sup>a</sup>	6.3 $\pm$ 1.1 <sup>a</sup>	8.3 $\pm$ 1.9 <sup>b</sup>	7.9 $\pm$ 2.3 <sup>b</sup>
Chewiness	3.4 $\pm$ 1.6 <sup>a</sup>	4.2 $\pm$ 1.8 <sup>ab</sup>	4.9 $\pm$ 1.7 <sup>abc</sup>	5.4 $\pm$ 0.7 <sup>bc</sup>	5.9 $\pm$ 2.0 <sup>cd</sup>	7.6 $\pm$ 1.5 <sup>d</sup>
Fibrousness	3.0 $\pm$ 1.3	4.3 $\pm$ 2.0	4.6 $\pm$ 1.9	4.5 $\pm$ 1.7	4.8 $\pm$ 2.4	5.7 $\pm$ 2.3
Moistness	9.0 $\pm$ 1.2 <sup>a</sup>	4.9 $\pm$ 1.2 <sup>b</sup>	4.5 $\pm$ 0.7 <sup>b</sup>	3.2 $\pm$ 1.1 <sup>b</sup>	5.1 $\pm$ 1.0 <sup>b</sup>	5.9 $\pm$ 1.1 <sup>b</sup>

<sup>1/</sup> n=6 panelists, mean scores within the same row with the same or without any superscripts are not statistically different (P > 0.05).

<sup>2/</sup> Total Intensity of Odor

<sup>3/</sup> Total Intensity of Flavor

Table 3. Sensory Ratings of Cooked Fillets Prepared from Vacuum Packaged H&G Hybrids (VHG)  
(Mean  $\pm$  S.D.; 15 cm Line Scale)<sup>1/</sup>

Months of Storage at -20°C						
	0	2	4	6	10	12
TIO <sub>2</sub> <sup>2/</sup>	2.5 $\pm$ 1.4 <sup>a</sup>	2.4 $\pm$ 1.5 <sup>a</sup>	3.6 $\pm$ 0.6 <sup>a</sup>	2.7 $\pm$ 0.7 <sup>a</sup>	3.3 $\pm$ 1.8 <sup>a</sup>	5.4 $\pm$ 2.6 <sup>b</sup>
TIF <sup>3/</sup>	5.3 $\pm$ 1.5 <sup>ab</sup>	4.0 $\pm$ 1.7 <sup>b</sup>	3.7 $\pm$ 0.8 <sup>b</sup>	4.1 $\pm$ 0.9 <sup>b</sup>	5.3 $\pm$ 2.6 <sup>ab</sup>	5.9 $\pm$ 1.2 <sup>a</sup>
Sweetness	2.5 $\pm$ 1.2	2.8 $\pm$ 1.6	1.3 $\pm$ 1.5	2.4 $\pm$ 1.2	2.4 $\pm$ 0.8	1.7 $\pm$ 1.4
Sourness	0.5 $\pm$ 1.1	0.2 $\pm$ 0.4	0.3 $\pm$ 0.7	0.2 $\pm$ 0.4	0.6 $\pm$ 0.5	0.9 $\pm$ 0.7
Earthiness	1.4 $\pm$ 1.4	1.0 $\pm$ 0.8	2.1 $\pm$ 1.9	1.4 $\pm$ 1.3	0.7 $\pm$ 1.0	0.8 $\pm$ 1.0
Rancidity	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.2 $\pm$ 0.5	0.0 $\pm$ 0.0	0.2 $\pm$ 0.5	0.0 $\pm$ 0.0
Salty-briny	1.5 $\pm$ 1.3	1.6 $\pm$ 1.0	0.8 $\pm$ 0.5	2.0 $\pm$ 1.4	- -	1.1 $\pm$ 0.7
Shellfish	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.3 $\pm$ 0.6	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0
Color	5.9 $\pm$ 1.0 <sup>ab</sup>	5.4 $\pm$ 1.3 <sup>ab</sup>	4.7 $\pm$ 1.2 <sup>a</sup>	5.0 $\pm$ 1.2 <sup>a</sup>	5.3 $\pm$ 1.4 <sup>ab</sup>	6.5 $\pm$ 1.8 <sup>b</sup>
Hardness	4.6 $\pm$ 2.0 <sup>ab</sup>	3.7 $\pm$ 1.5 <sup>a</sup>	3.7 $\pm$ 1.5 <sup>a</sup>	4.6 $\pm$ 0.4 <sup>ab</sup>	5.5 $\pm$ 1.4 <sup>bc</sup>	6.4 $\pm$ 1.4 <sup>c</sup>
Flakiness	5.9 $\pm$ 1.1 <sup>a</sup>	5.6 $\pm$ 2.1 <sup>a</sup>	5.4 $\pm$ 0.9 <sup>a</sup>	6.8 $\pm$ 1.6 <sup>ab</sup>	8.4 $\pm$ 2.1 <sup>b</sup>	8.1 $\pm$ 2.1 <sup>b</sup>
Chewiness	3.0 $\pm$ 1.0 <sup>a</sup>	4.7 $\pm$ 2.0 <sup>ab</sup>	3.7 $\pm$ 1.2 <sup>a</sup>	4.6 $\pm$ 0.4 <sup>ab</sup>	6.4 $\pm$ 2.5 <sup>c</sup>	6.0 $\pm$ 1.1 <sup>bc</sup>
Fibrousness	3.4 $\pm$ 1.7	4.0 $\pm$ 2.0	4.6 $\pm$ 1.7	3.8 $\pm$ 1.3	5.1 $\pm$ 2.6	5.1 $\pm$ 1.6
Moistness	8.3 $\pm$ 2.2 <sup>a</sup>	6.9 $\pm$ 1.1 <sup>a</sup>	4.5 $\pm$ 0.8 <sup>b</sup>	4.3 $\pm$ 0.8 <sup>b</sup>	6.5 $\pm$ 1.7 <sup>a</sup>	6.9 $\pm$ 1.8 <sup>a</sup>

<sup>1/</sup> n=6 panelists, mean scores within the same row with the same or without any superscripts are not statistically different (P > 0.05).

<sup>2/</sup> Total Intensity of Odor

<sup>3/</sup> Total Intensity of Flavor

Table 4. Sensory Ratings of Cooked Fillets Prepared from Glazed and Boxed H&G Hybrids (GHG)  
(Mean  $\pm$  S.D.; 15 cm Line Scale)<sup>1/</sup>

Months of Storage at -20°C						
	0	2	4	6	10	12
TI0 <sup>2/</sup>	2.5 $\pm$ 1.4 <sup>a</sup>	2.6 $\pm$ 1.7 <sup>a</sup>	3.4 $\pm$ 0.9 <sup>ab</sup>	3.1 $\pm$ 1.3 <sup>a</sup>	3.9 $\pm$ 1.2 <sup>ab</sup>	5.0 $\pm$ 1.8 <sup>b</sup>
TIF <sup>3/</sup>	5.3 $\pm$ 1.5 <sup>ab</sup>	4.0 $\pm$ 1.4 <sup>b</sup>	4.0 $\pm$ 1.8 <sup>b</sup>	4.2 $\pm$ 1.3 <sup>ab</sup>	4.8 $\pm$ 1.3 <sup>ab</sup>	6.0 $\pm$ 1.4 <sup>a</sup>
Sweetness	2.5 $\pm$ 1.2	2.2 $\pm$ 1.4	1.7 $\pm$ 1.2	3.1 $\pm$ 1.6	1.8 $\pm$ 0.3	1.6 $\pm$ 1.2
Sourness	0.5 $\pm$ 1.1	0.1 $\pm$ 0.3	0.5 $\pm$ 0.9	0.7 $\pm$ 0.9	0.3 $\pm$ 0.4	0.7 $\pm$ 0.4
Earthiness	1.4 $\pm$ 1.4	1.1 $\pm$ 0.9	2.0 $\pm$ 1.7	1.5 $\pm$ 0.8	0.7 $\pm$ 0.9	0.8 $\pm$ 1.2
Rancidity	0.0 $\pm$ 0.0	0.1 $\pm$ 0.3	0.0 $\pm$ 0.1	0.0 $\pm$ 0.0	0.2 $\pm$ 0.5	0.3 $\pm$ 0.5
Salty-briny	1.5 $\pm$ 1.3	1.4 $\pm$ 1.0	0.8 $\pm$ 0.5	1.8 $\pm$ 1.2	- -	1.2 $\pm$ 0.8
Shellfish	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0
Color	5.9 $\pm$ 1.0 <sup>ab</sup>	5.8 $\pm$ 1.4 <sup>ab</sup>	5.6 $\pm$ 1.6 <sup>ab</sup>	4.1 $\pm$ 1.9 <sup>c</sup>	5.2 $\pm$ 1.0 <sup>bc</sup>	6.6 $\pm$ 1.6 <sup>a</sup>
Hardness	4.6 $\pm$ 2.0 <sup>a</sup>	4.5 $\pm$ 1.6 <sup>a</sup>	4.7 $\pm$ 1.3 <sup>a</sup>	6.0 $\pm$ 2.0 <sup>ab</sup>	6.2 $\pm$ 2.9 <sup>ab</sup>	7.3 $\pm$ 1.5 <sup>b</sup>
Flakiness	5.9 $\pm$ 1.1 <sup>ab</sup>	4.8 $\pm$ 0.8 <sup>a</sup>	6.2 $\pm$ 0.5 <sup>ab</sup>	7.3 $\pm$ 0.7 <sup>bc</sup>	8.6 $\pm$ 1.5 <sup>c</sup>	8.1 $\pm$ 2.2 <sup>c</sup>
Chewiness	3.0 $\pm$ 1.0 <sup>a</sup>	4.5 $\pm$ 1.2 <sup>ab</sup>	5.1 $\pm$ 1.6 <sup>b</sup>	4.3 $\pm$ 0.5 <sup>ab</sup>	5.2 $\pm$ 2.2 <sup>b</sup>	7.3 $\pm$ 2.1 <sup>c</sup>
Fibrousness	3.4 $\pm$ 1.7	4.5 $\pm$ 2.0	4.2 $\pm$ 1.6	3.9 $\pm$ 2.6	5.0 $\pm$ 2.5	5.6 $\pm$ 2.7
Moistness	8.3 $\pm$ 2.2 <sup>a</sup>	6.5 $\pm$ 1.9 <sup>a</sup>	4.3 $\pm$ 0.6 <sup>b</sup>	6.7 $\pm$ 0.7 <sup>a</sup>	6.3 $\pm$ 1.8 <sup>a</sup>	6.5 $\pm$ 1.9 <sup>a</sup>

<sup>1/</sup> n=6 panelists, mean scores within the same row with the same or without any superscripts are not statistically different (P > 0.05).

<sup>2/</sup> Total Intensity of Odor

<sup>3/</sup> Total Intensity of Flavor



Table 5. TBA Values of Raw Hybrid Striped Bass Fillets<sup>1/</sup>

	Months of Storage at -20°C				
	0	2	4	10	12
<u>Vacuum Packaged Skinless Fillets</u>	0.3	0.4	3.9	3.5	5.8
<u>Glazed and Boxed Skinless Fillets</u>	0.3	0.4	3.9	3.5	3.0
<u>Vacuum Packaged H&amp;G Hybrids</u>	0.3	1.5	2.8	1.7	1.6
<u>Glazed and Boxed H&amp;G Hybrids</u>	0.3	1.0	2.4	1.0	1.0

<sup>1/</sup>umoles/kg wet weight; average of duplicate determinations.

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