Reducing the Minimal-Legal Harvest Size of Oysters in Georgia

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Abstract

This paper examines the basic reproductive biology of the eastern oyster, *Crassostrea virginica* (Gmelin, 1791), in coastal Georgia in relation to state regulations for setting the minimal-legal- size limit for harvesting oysters. Minimal-legal-size limits are established to ensure that commercially exploited species have the opportunity to reproduce at least once prior to being available for harvesting by fishers. Oysters start gametogenesis in January and are ripe by April. Spawning starts in April and may continue through October. Annual recruitment is highly variable year to year, but overall oyster spat recruitment is continuous over summer from April to November and occurs at a high rate. Monthly recruitment rates of 10,000 spat per square meter per month are common and rates have been recorded as high as 204,700 per meter square per month. Mean ten year seasonal recruitment rate in the Duplin River are 11,000 spat per month over the seven month spawning season at two of three sites in the Duplin River. Little recruitment occurred in the headwaters of the Duplin River. Annual peak recruitment may occur in spring, summer or during both periods. Oysters in Georgia are predominately females. An oyster spat spawned in spring, grows rapidly, and reaches sexual maturity at a size of approximately 25.4 mm (1 inch) in 2 to 3 months and will contribute to the late summer spawning within its first year of life. A current minimal-legal size of 76.2 mm (3 inches) exists for oysters in Georgia. In view of the fact that oysters can spawn continuously over summer, young-of-the-year spat spawn at 25.4 mm (1 inch) in summer/fall, large amounts of oyster stocks occur in vast coastal areas where oyster harvesting is prohibited, and considering the large amount of spat production that occurs naturally, a minimal-legal-size limit of 76.4 mm (3 inches) makes little sense for oysters in Georgia. It is recommended that Georgia Department of Natural Resources make provisions to lower the minimal-legal-size from 76.2 mm (3 inches) to 50.8 mm (2 inches) to encourage the growth and expansion of the developing Georgia oyster aquaculture fishery.

Introduction

The eastern oyster, *Crassostrea virginica* (Gmelin, 1791), is an important commercial, ecological and recreational species in coastal Georgia. The oyster has been an important estuarine species for man since our first appearance on the coast of Georgia. Numerous oyster shell middens created by native Indians occur along the coast with the "Shell Ring" located on Sapelo Island being the largest (Sullivan 1997). Native Indians, early European settlers, and coastal residents have harvested, sold and/or consumed oysters in Georgia for thousands of years (Sullivan 1997). Georgia led the nation in oyster harvesting in 1908 with 3.6 million kg (8 million pounds) of meat landed mainly for the cannery (Oemler 1894) and shucking industries (Harris 1980). Thirteen canneries occurred along the coast (Harris 1980). By the 1930's the industry was in decline and by 1970s less than 45,359 kg (100,000 pound) of meats were being landed annually. Overharvesting and mismanagement of the fishery lead to its collapse (Ofiara and Stevens 1987). From 1957 to 1966, most oysters were sold in state as a shucked product with lesser amounts sold as live oysters (Carley and Frisbie 1968). The shucking industry has died out primarily from the inability to keep a work force (Ofiara and Stevens 1987). Presently, no oyster shucking houses are in operation in Georgia. Today, oysters are harvested primarily in fall and winter for the sack trade, where live oysters are sold locally for oyster roasts. Georgia also maintains nine public shellfish picking areas in which the public can gather oysters. Each individual may pick two bushels of oysters with a single boat allowed up to a total of six bushels per boat. Oyster reefs are considered essential fish habitat and as such are popular areas used by coastal recreational fishers.

Oyster reefs also provide various ecological services such as: 1) significantly improve both water quality and clarity within their vicinity, because of oysters efficiency as filter feeders; 2) dissipate wave energy caused by boat traffic, wind/storm and tidal activity, and thus can protect marshes and adjacent uplands from shoreline erosion; and 3) provide essential fish habitat for many commercial, ecological and recreational fish species. Oyster reefs are classified as essential fish habitat (EFH) and federal legislation has authorized managers to restore, protect, preserve, and enhance EFH habitats (2007 Magnuson-Stevens Fishery Conservation and Management Act). Reefs provide a three dimensional structure for small motile organisms to shelter within and habitat for numerous benthic invertebrates, pelagic fish, and invertebrates (Dame 1996, Wenner *et al.* 1996, Posey *et al.* 1999, Lehnert and Allen 2002, Luckenbach *et al.* 2005). Many species of fish and invertebrates utilize and depend upon oyster reefs as a home or an area to locate prey, to spawn and lay eggs, or an area for juveniles to hide and seek protection from predators (Coen *et al*. 1999). Forty-two species of invertebrates and fish live on intertidal oyster reefs in Georgia (Bahr and Lanier 1981) with many more species moving onto and off the reefs with the tides (Coen *et al*. 1999). Consequently, the loss of oysters and associated oyster reef habitat has a direct impact on the ecosystem as well as the local economy.

Georgia has the potential to become an important oyster producing state. By utilizing aquaculture technology, the oyster industry in Georgia will be a self sustainable industry unlike the old natural wild stock take industry which impacted the population. The Marine Extension Service has developed sustainable aquaculture methods which can utilize the collection of natural oyster recruitment called spat (Manley *et al*. 2008a) and use these animals as a source of seed for oyster

farms (Manley *et al*. 2009a). There is an over abundance of oyster spat in Georgia which causes overcrowding on natural reefs resulting in a poor quality oyster which is long, thin and narrow in shape and is referred to as a "coon" oyster (Galtsoff 1964). The overcrowding results in competition for space and food. Oysters from natural reefs grow at approximately 2.5 cm annually (Galtsoff and Luce 1930) and oysters may require three years to reach a legal-minimal harvest size of 76.2 mm (3 inches) when grown on the bottom in Georgia (Ofiara and Stevens 1987). Manley (2007) found that oysters grown off bottom on sticks could grow to market size in one year. This rapid growth rate of oysters grown off-bottom has resulted in the shellfish industry wanting to diversify its industry from farming hard clams, *Mercenaria mercenaria* (Linnaeus, 1758), to expand into farming oysters as well.

With the oil spill disaster of the BP Deepwater Horizon in the Gulf of Mexico in 2010, oyster prices have soared as public perception of oil contaminated oysters have greatly affect that industry with sales that soon plummeted.

A minimal legal-size limit for the harvesting of an animal is generally set at a size after the organism has grown to sexual maturity and has been allowed to spawn at least once prior to being allowed to be harvested. The current minimal-legal-size limit for the taking of oysters has been in place for a long time, prior to any sustained scientific examination of oyster biology in Georgia. A 76.2 mm limit is the size that oysters sexually mature in more northern waters. It may take oysters several years to obtain this size in the colder waters of the northeast. This paper examines the basic biology of the oyster in Georgia, the current fishing practice, future aquacultural practices, and re-examines the current size limit for the taking of oysters in Georgia.

Distribution

Georgia has almost one third of the salt marshes along the east coast of United States wherein oysters live. There are 429,294 acres of tidal marshes of which 378,000 acres are salt marshes. Oysters occur as singles, clumps to massive reefs or mounds throughout the intertidal banks of tidal creeks, rivers and sounds of the salt marshes (Drake 1891, Galtsoff and Luce 1930, Linton 1968, Harris 1980, Bahr and Lanier 1981, Walker and Cotton 2001, Power *et al.* 2010). Oysters occur in subtidal areas only around the mouth of the Altamaha River area (Harris 1980). Oysters survive well in areas where salinity is above 5 ppt (Galtsoff 1964).

Drake (1891) reported a total of 7,109,517 m^2 of oyster habitat in Georgia, while Harris (1980) reported only 1,096,698 m^2 of oyster beds. This would tend to indicate a massive loss of oyster beds over time; however, a recent survey (Power *et al*. 2010) of select areas in Georgia showed that current estimates of oyster reef coverage are more comparable to Drake's (1891) estimates and than that of Harris (1980) who apparently drastically under estimated the oyster stocks. "The totals in the Harris (1980) survey only represented 1.01% of the habitat we described on Cabbage Island, 2.09% in Romerly Marsh, 7.7% in the different creeks near Colonels Island and 4.24% in the Timmons River" (Power *et al.* 2010). A survey of oyster resources in the Duplin River where a sizeable commercial oyster industry occurred (Sullivan 1997) did show a dramatic decrease in oyster beds (Walker and Cotton 2001).

Many of our coastal areas are considered pristine and as such have good water quality. Many of our barrier islands are owned by the state or the federal governments and are protected from residential or commercial development, the prime sources of non-point pollution in America's coastal areas. All of the commercial and recreational oyster beds occur in these pristine areas. In the past, oyster beds were delineated according to areas that were permanently closed due to poor water quality, conditional areas that could be opened to harvesting if water quality standards warranted their opening, and areas that generally have good water quality year around. In the event of declining water quality, even these areas can be closed by the Georgia Department of Natural Resources. Due to state budget cuts, Georgia Department of Natural Resources no longer monitors water quality in the conditional areas. Thus, today oyster beds occur in areas that are either closed or are open for commercial harvesting as long as water quality remains at safe levels.

Reproduction

The reproductive biology of the oyster in Georgia is well documented (Durant 1967; Heffernan *et al.* 1989; O'Beirn *et al.* 1996c). Oysters initiate gametogenesis in January with oysters diverting energy from growth and shunting it into reproductive efforts. Oysters quickly become ripe by April. Spawning starts in April and/or May and continues through October (Durant 1967, Heffernan *et al*. 1989; O'Beirn *et al*. 1996c, 1997) (Table 1). In the Duplin River, Sapelo Island, spawning occurred with an approximate two week delay between oyster beds at the mouth, half way up the river and at the headwaters (O'Beirn *et al*. 1996c). By October the oyster gonad is spent. By September oysters again shunt energy away from reproduction and back into growth. Condition Indices, a relative index of nutritional quality of the meat, increase over winter, reaching a maximum in February and decrease in April as spawning is initiated (Manley and Walker 2011). Glycogen levels, stored carbohydrates, follow a similar pattern to that of the gametogenic cycle and condition indices patterns: glycogen levels peak in winter and drop to minimum levels during summer while oysters are spawning (Parks 1967).

Larval development

Eggs and sperm during spawning are released into the water column where fertilization occurs. Eggs go through a trochophore larval stage within 24 hours and develop into a veliger larval stage. Depending upon water temperature and salinity, larvae will remain in the water column for 7 to 10 days before metamorphosing into a baby oyster referred to as a spat. Spat cement themselves to a clean hard substrate where they will remain the rest of their life.

An oyster spat spawned in April/May will grow quickly and become sexually mature in two to three months at approximately a 25 mm shell length size and will contribute to the fall spawn (O'Beirn *et al*. 1996b).

Table 1. Monthly oyster recruitment patterns in the intertidal zone for coastal Georgia

Location	Year	Recruitment period	peak(s)	Peak monthly Value /0.01 m^2	Reference
St Catherines Sound	2006	May to October	June Aug	525.4 Aug	Manley *et al*. 2010b
Sapelo Sound	2006	May to October	June	981.32	Manley *et al*. 2008b
Duplin River	1992	June to October	Aug	350.3	O'Beirn *et al*. 1994
Duplin River	1993	May to September	May	301.5	O'Beirn *et al*. 1996c
Duplin River	1999*	June to October	June Sept.	383.3 Sept.	Thoresen *et al*. 2005
Duplin River	2000	April to October	May Aug.	875.1 Aug.	Thoresen *et al*. 2005
Duplin River	2001*	June to October	June Aug.	2,046.8 Aug.	Thoresen *et al*. 2005
House Creek	1991	May to October	July-Sept	43.8	O'Beirn *et al*. 1995
Priest Landing	1991	June to October	July	10.1	
Skidaway River	1991	May to October	August	32.0	
House Creek	1993	May to October	May	225.6	O'Beirn *et al*. 1996a
Skidaway River	1993	May to October	May July	~20.0**	
Skidaway River	1994	May to September	July	26.3	
House Creek	1996	May to October	June	650.0	Moroney and Walker 1998
Duplin River	1997	May to June***	June 16	ND	Furukawa and Linton 1967

Table 1 continued

*Sampling started in May, thus may have missed earlier recruitment
** Value not stated, but estimated from graph
***Sampled daily only from May 30 to June 24

Sex Ratio

Oysters are dioecious, but males may change to females (protandry) or females to males (protogyny) yearly (Bahr and Lanier 1981). Oysters generally mature as a male (Coe 1943, Galtsoff 1964, Andrews 1979) but can change sex within a season or between seasons (Galtsoff 1964). In Georgia, oyster spat spawned early in the season (April/May), matured rapidly within a few months (O'Beirn *et al*. 1996b) and these young-of-the-year oysters have an equal sex ratio (Table 2). Older oysters in Georgia are dominated by females by a factor of 2 to 3 females per male (Table 2). O'Beirn *et al*. (1998) found that greater numbers of females occur in oysters found inhabiting areas in the mid intertidal zone within marsh grass than in the intertidal lower levels where oyster normally occur. Higher proportions of males have been attributed to overcrowding of oysters (Burkenroad 1931, Smith 1949, Menzel 1951), starvation or availability of poor food quality (Bahr and Hillman 1967). Georgia oyster beds are dense due to high recruitment rates, but our estuaries are very productive so food resources do not appear to affect the sexuality of oysters in Georgia.

Condition Index and Glycogen

Condition Index is an estimate of the relative nutritional status of an organism, while glycogen is the energy reserve material of the oyster. Glycogen reserves are stored in the body over fall and winter in oysters and are rapidly utilized in the formation of eggs and sperm once gametogenesis starts. Once spawning starts glycogen rapidly decreases as eggs and sperm are released into the water column. After spawning, glycogen levels reach their lowest levels in June-July, and are low during the rest of the spawning season (Parks 1967). The condition index of an oyster is an expression of its overall nutritive status (Manley and Walker 2011). Condition index annual pattern closely follows that of the glycogen annual cycle. Values peak in winter and rapidly decrease during spawning and remain low through summer (Figure 1).

Table 2. Reported sex ratio in Georgia oyster stocks

Location	No.	Date	Sex Ratio (F:M)	Reference
Young-of-the Year				
House Creek, Wassaw Sound	62	1991	0.55:1.00	O'Beirn *et al.* 1996a
Skidaway River, Wassaw Sound	61	1991	0.64:1.00	
Skidaway River, Wassaw Sound	140	1993	1.12:1.00	
Adults				
House Creek, Wassaw Sound		1984-6	3.00:1.00*	Heffernan *et al.* 1989
House Creek, Wassaw Sound	44	1991	0.83:1.00	O'Beirn *et al.* 1996b
Skidaway River, Wassaw Sound	58	1991	1.90:1.00	
Skidaway River, Wassaw Sound	63	1993	2.20:1.00*	
Marsh Landing, Doboy Sound	221	1983-4	2.16:1.00*	O'Beirn *et al.* 1997
Jack Hammock, Doboy Sound	288	1983-4	1.64:1.00*	
Flume Dock, Doboy Sound	313	1983-4	1.85:1.00*	
House Creek/Skidaway River, Wassaw Sound	1,576	1993-4	2.47:1.00*	O'Beirn *et al.* 1998

*Significantly different from parity

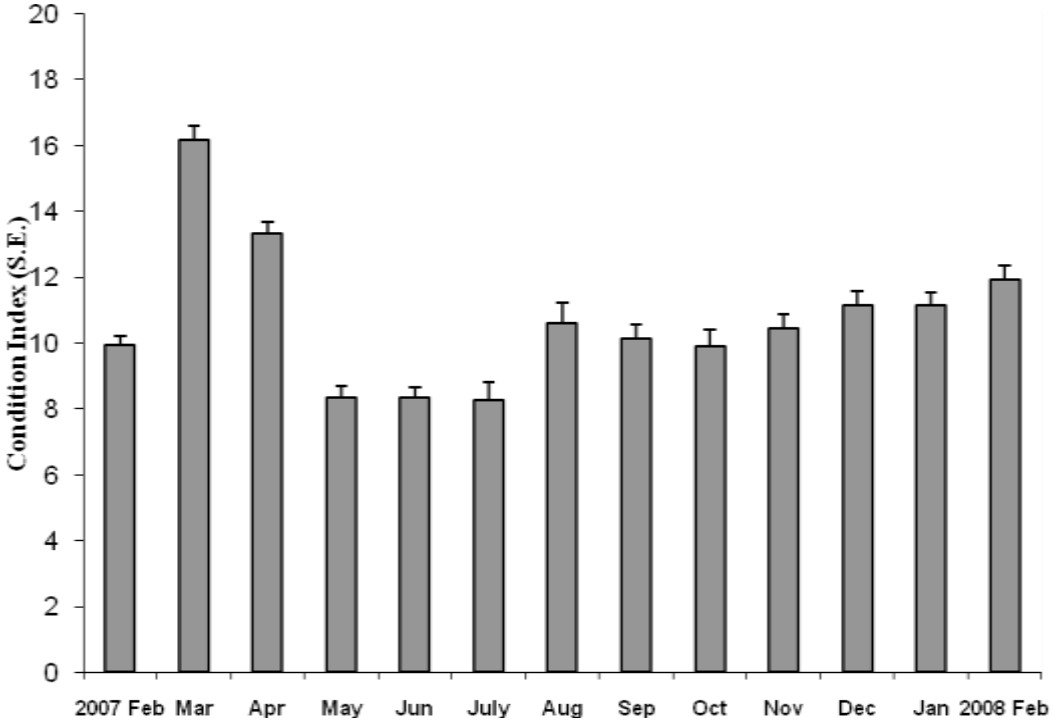

Figure 1. The condition index of oysters in Georgia from Manley *et al.* (2011)

Recruitment

Oyster recruitment studies in Georgia show that recruitment occurs from April to October/November (Table 1) (O'Beirn *et al*. 1994, Thoresen *et al*. 2005, O'Beirn *et al*. 1996a,c, Manley *et al*. 2008b, Manley *et al*. 2010b). Three patterns of recruitment are generally seen; 1) a peak recruitment in May/June with lesser recruitment throughout the summer and fall; 2) a peak recruitment event in August/September with lesser spawning prior to and after August/September; or 3) a spring May/June peak followed with a second peak in August/September. The third pattern is the common recruitment pattern (Table 3). Recruitment occurs from subtidal areas and up through the intertidal zone to the salt marsh area which generally starts just above the top of intertidal oyster reefs. O'Beirn *et al*. (1995) found greater recruitment on a biweekly sampling in subtidal areas than at low water with lesser recruitment at the two-above-mean low-water mark where oysters occur naturally. Greatest recruitment occurred at the low water mark for monthly sampling, but greatest recruitment occurred at the two-hours-above mean-low water on a seasonal basis. The seasonal shift in recruitment pattern is related to predation pressure. Subtidal recruitment is heavily preyed upon by a host of natural predators including blue crabs, oyster drills, mud crabs, etc. Many predators, such as whelks (Walker 1988, Walker *et al.* 2008), drills (Walker 1981) and *Cliona* sp. (Linton 1968), occur subtidally and to the low water mark, but cannot survive above the low water mark, thus there is

a refuge area away from most predation for oysters at the two-hours-above mean-low water. O'Beirn *et al*. (1996d) showed that subtidal oysters can survive the season if enclosed in predator exclusion mesh bags.

Table 3. Reported spawning periods and peak(s) for Georgia oysters

Location	Year	Spawning period	Peak(s)		Reference
Sapelo Sound	2006	May to October	June	August	Manley *et al.* 2008b
St Catherines Sound	2006	May to October	June	August	Manley *et al.* 2010b
Duplin River	2001	June to September*	August		Thoresen *et al.* 2005
Duplin River	2000	May to September	May	August	Thoresen *et al.* 2005
Duplin River	1999	June to October*	June	September	Thoresen *et al.* 2005
Skidaway River	1994	April to August	May		O'Beirn *et al.* 1996a
House Creek	1994	April to August	April		O'Beirn *et al.* 1996a
Priest Landings	1994	May to August	May		O'Beirn *et al.* 1996a
Duplin River	1993	May to September	August		O'Beirn *et al.* 1996c
Skidaway River	1993	April to July	May		O'Beirn *et al.* 1996a
House Creek	1993	May to October	May		O'Beirn *et al.* 1996a
Priest Landings	1993	May to July	May		O'Beirn *et al.* 1996a
Duplin River	1992	June to October*	August		O'Beirn *et al.* 1994
Skidaway River	1992	May to October	July		O'Beirn *et al.* 1996a
Priest Landings	1992	May to October	August		O'Beirn *et al.* 1996a
House Creek	1992	May to October	August		O'Beirn *et al.* 1996a
Skidaway River	1991	May to September	July		O'Beirn *et al.* 1996a
Priest Landings	1991	July to September	August		O'Beirn *et al.* 1996a
House Creek	1991	May to September	August		O'Beirn *et al.* 1996a

*Started sampling in June or May thus missing early part of spawning season

Table 4. Mean seasonal monthly recruitment rate (total spat recruitment divided by 7 months; May to November) of spat at three sites within the Duplin River, Sapelo Island National Estuarine Research Reserve (Walker unpublished data)

Location	Year	Seasonal Rate No./0.01 m^2/month	Spawning period	Peak month(s) No./0.01 m^2/month
Marsh Landings	2002	199.46	May to October	July 593.7; September 159.9
Jack Hammock		12.32	May to October	May 281.1
Flume Dock		0.77	August to October	August 3.3
Marsh Landings	2003	66.10	May to November	June 324.6
Jack Hammock		81.68	May to October	June 337.9
Flume Dock		0.61	June to September	August 2.4
Marsh Landings	2004	62.87	May to October	June 390.78
Jack Hammock		46.39	May to October	June 258
Flume Dock		0.68	June to October	June 4.44
Marsh Landings	2005	48.09	June to November	July 212.33
Jack Hammock		32.57	June to September	July 171.22
Flume Dock		0.06	June	June 0.44
Marsh Landings	2006	151.12	June to November	September 485.62
Jack Hammock		73.59	June to November	September 219.44
Flume Dock		4.25	July to October	September 25.22
Marsh Landings	2007	115.96	May to October	June 520.74
Jack Hammock		61.74	May to October	June 286.22
Flume Dock		0	None	None
Marsh Landings	2008	134.0	June to November	July 519.89
Jack Hammock		85.19	June to November	July 330.89
Flume Dock		0.03	July	July 0.22
Marsh Landings	2009	128.65	May to October	May 450.11; August 368.33
Jack Hammock		475.01	May to October	June 1,661; August 309.67
Flume Dock		3.76	May to August	June 13.89
Marsh Landings	2010	132.27	May to October	May 591.4
Jack Hammock		250.29	May to November	May 1,220.89
Flume Dock		1.23	June to September	September 4.83
Marsh Landings	2011	121.86	May to October	September 315.89
Jack Hammock		55.34	May to September	July 139.11
Flume Dock		0.33	June to September	June 0.88
Ten Year means				
Marsh Landings		116.04		
Jack Hammock		117.41		
Flume Dock		1.17		

Georgia oysters are very productive routinely producing 10,000 to 30,000 oyster spat per meter square monthly during peak periods (Table 4) with a record high recruitment period of 204,700 spats per meter square August 2001 (Thoresen *et al*. 2005).

Discussion

The University of Georgia has documented that oysters in Georgia grow year around, and start their reproductive cycle in January, sexually mature by April and begin spawning in April/May (Durant 1967, Heffernan *et al.* 1989, O'Beirn *et al.* 1996b, 1996c, 1997, 1998). Recruitment of new spat (babies) onto oyster beds starts in May. Spawning continues through October with recruitment occurring into October/November (Moroney and Walker 1988, O'Beirn *et al.* 1996a,c,d, 1995, 1994, Thoresen *et al.* 2005, Manley *et al.* 2008b, 2010a,b). A spat that recruits and settles in April/May will grow rapidly to approximately 25 to 38 mm in shell length (an inch to an inch and a half in size), can sexually mature within two to three month period, and begin spawning in its first summer contributing to the fall recruitment (O'Beirn *et al.* 1996b). Spawning is a continuous process from April to October with either one or two major peaks of actively. In northern oyster populations, recruitment levels of 30 to 50 spat per square meter per season is considered good. In Georgia we have documented recruitment levels as high as 204,700 spat per square meter per month. Recruitment rates during peak events from 10,000 to 30,000 spat per square meter per month are routine in coastal Georgia. Georgia has an overabundance of oyster spat which can be utilized for the development of a sustainable aquaculture industry.

Oyster aquaculture offers a means of recreating an oyster based fishery. A sustainable oyster aquaculture industry can be developed that does not destroy the natural stocks as occurred in the past and lead to the collapse of the 1908 oyster based cannery industry by the 1930s. An oyster aquaculture industry can collect oyster spat from the water column and grow these to market size without harming local stocks. It takes 18 months for oysters to grow to the present 76 mm (3 inches) legal size limit when grown on the intertidal river bottom. Newly developed off-bottom methods have produced legal size oysters in 9 to 10 months (Manley 2006, Manley *et al.* 2010a, Bliss *et al.* 2012). Oyster spat caught in April/May can grow to market size by March/April, the end of the traditional Georgia oyster roast season. Most oysters harvested in Georgia are sold in the sack trade where oysters are used in the late fall/winter oyster roast season.

To promote an oyster aquaculture industry in Georgia, industry wishes to decrease the minimal-legal-size limit for the harvesting of oysters from 76.2 mm (3 inch) to 50.8 mm (2 inches). First there is no resource management problem with the lack of recruitment of oyster spat into the present oyster beds. We have an overabundance of spat being produced. The problem with expanding the stocks is the lack of suitable clean cultch (any clean substrate like shell or live oysters) substrates for the oyster spat to attach to in a mud bottom dominate estuarine ecosystem. Second unlike up north, Georgia oysters grow year around and reproduction is a 6 to 7 months process. The State of Georgia requires commercial harvesters to return cultch material to oyster beds. Timing is important. Many harvesters return cultch during fall/winter while they are

harvesting oysters. Shell should be held until May before being returned to oyster beds. Placing cultch material on oyster beds in non-spawning periods, fall to spring, serves little purpose if the harvesters wish to provide material for spat to attach. By spring the shell will be dirty and not so suitable for attracting spat. Cultch needs to be deployed during the spawning season. Oysters in Georgia sexually mature at a much smaller size and within 2 to 3 months than those from northern colder waters which may require several years to obtain sexual maturity. Thus, there is no need to protect oysters up to the 76.2 cm (three inch) size in coastal Georgia.

The University of Georgia working with the Georgia Shellfish Industry would like to lower the minimal-legal-size limit to 50.8 mm (2 inches). Minimal-legal-size limits are imposed to protect the natural resource. Such size limits are enacted to ensure that a species has at one opportunity to reproduce before it is potentially removed from the population by harvesting. Hopefully such a size limit will protect the sexually mature individuals (spawners) long enough to ensure future generations. Georgia currently has a 76.2 mm (3 inch) size limit to protect spawning oysters. Georgia's size limit is similar to that of many northern states. Up north oysters do not sexually mature in the colder waters until they obtain a 76.2 mm (3 inch) size. In more northern oyster grounds it may require many years of growth to reach sexual maturity. A 76.2 mm (3 inch) size limit for harvesting oysters in Georgia makes no sense.

By reducing the minimal-legal-size limit of 76.2 mm (3 inch) for harvesting oysters to 50.8 mm (2 inches), smaller oysters can be marketed in the sack trade in late fall to early spring, as well as, the more lucrative halfshell live markets. The off-bottom techniques developed for culturing oysters in Georgia produces 76.2 mm (3 inch) oysters by the end of the oyster roast season. By decreasing the legal size, oysters cultured by this method could be harvested much earlier in the sack trade season, certainly by Christmas, a peak in the sale of sack oysters. More importantly there exists a lucrative market for a 50.8 mm (2 inch) oyster, where they are sold in the cocktail oyster trade (Manley *et al.* 2009b). A substantial oyster cocktail trade exists in the northwest United States. Raw oysters of 50.8 mm (2 inches) are sold in high end bars and restaurants as appetizers along with drinks

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