

**Marketing Opportunities for Two Ark Clam Species:  
Blood Ark Clams (*Anadara ovalis*)  
And  
Ponderous Ark Clams (*Noetia ponderosa*)**

**By**

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## ABSTRACT

In 2002-2003, a survey of certified shellfish dealers in the U.S. was conducted to determine the current state of the market and sales potential for aquacultured Blood Ark (*Anadara ovalis*) and Ponderous Ark (*Noetia ponderosa*) clams. The survey revealed extremely limited trade awareness of the two species of clams; over 90 percent of all shellfish dealers were unfamiliar with them. Only one percent of responding firms reported selling these species of clams in 2002, and sales were very limited. However, nearly one-third of all respondents were willing to evaluate product samples of both species. In November 2003, the sub-sample of 102 firms that had initially agreed to evaluate samples of the two types of clams was contacted by telephone to confirm their willingness to evaluate product samples. Of these, a total of 82 firms agreed to examine and evaluate samples, but only 52 provided usable evaluations despite telephone follow up calls. The consensus of responding firms was that both species of ark clams had limited appeal to their traditional clam customers, but could be successfully marketed to ethnic consumers, particularly Hispanics and Asians.



## EXECUTIVE SUMMARY

- Significant growth in Florida's hard clam (*Mercenaria mercenaria*) industry has motivated aquaculturists to explore alternative molluscan shellfish species to reduce potential production risks and augment market expansion. Diversity of species could possibly provide some degree of protection against catastrophic losses.
- Two alternative clam species with commercial potential are the Blood Ark (*Anadara ovalis*) and the Ponderous Ark (*Noetia ponderosa*). In the United States, wild stocks of Blood Arks range from Massachusetts to Texas. They are also found in the Caribbean and coasts of Brazil. The Ponderous Ark is found from Virginia to Florida and from the Florida Keys to Texas. Wild stocks of the Blood Ark and Ponderous Ark clams are currently harvested in North Carolina and Virginia in limited quantities for ethnic markets in the United States.
- The development of a major fishery for these species has been limited by a variety of factors, including dispersed wild ark clam populations, minimal understanding of clam reproduction, isolated ethnic markets. Until recently, these clams have been largely overlooked by the shellfish and fishing industries.
- This research quantifies the shellfish trade's present awareness and acceptance of the Blood Ark and Ponderous Ark clams as a first step in evaluating the economic feasibility of producing these clams under aquacultured conditions. The basic objective of this study was to determine the present market potential of Blood Ark and Ponderous Ark clams in the U.S.
- This study was conducted in three phases. The first was a nationwide census of all certified shellfish shippers (dealers). Questionnaires were mailed to 2,133 firms to determine the current market situation for the two selected species of ark clams. Phase I also identified 83 firms that were willing to evaluate live samples of the clams for the second phase of the study.
- In Phase II, 83 firms received live samples of the two types of ark clams, and they were asked to evaluate a number of basic product characteristics, including appearance and organoleptic qualities. These cooperators were also asked to estimate potential sales through their respective firms.
- Phase III focused on physical attributes of the ark clams, specifically nutritional analyses of Blood Ark and Ponderous Ark clam meats, and on the shelf life of live animals.
- **PHASE I:** About 92 percent of the responding shellfish firms have had no experience with Blood Ark clams. Only one percent of respondent firms sold Blood Ark clams during 2001, thus it is apparent that market exposure in the U.S. is extremely limited.
- Among certified shellfish shippers that responded to the questionnaire, over 90 percent have had no experience with Ponderous Ark clams. Less than two percent have seen them at trade shows, and only one percent sold them in the past. With only one respondent currently selling Ponderous Arks, market exposure is presently extremely limited.



- It appears that the present market for the Blood Ark and Ponderous Ark clams is extremely limited, due to limited trade knowledge of the products and inconsistent supplies at the producer and consumer levels. Respondents mentioned the lack of consistent supplies, limited market outlets and virtually nonexistent consumer demand.
  - On a positive note, some shellfish shippers indicated an interest in learning more about these ark clam types. Out of 309 respondents, 97 provided mailing address information and requested Blood Ark clam samples, and 96 gave contact information in order to receive Ponderous Ark clam samples. However, when samples became available, only 83 firms agreed to accept and evaluate them.
  - **PHASE II:** Samples of the two ark clam species were harvested from approved shellfish waters in mid-November 2003, and held overnight in a refrigerated facility owned by a certified shellfish processor in Cedar Key, Florida. A sample of six Blood Ark clams, ranging in size from medium to large, and a combined sample of nine medium and six large Ponderous Ark clams were placed in separate small, color-coded plastic mesh bags with the processor's dealer tags affixed to each bag. The two bags of clams were placed in an insulated shipping container made of expanded polystyrene foam along with a frozen eight-ounce gel pack. The foam shipper was then placed inside a small, corrugated cardboard container along with evaluation instructions and a one-page questionnaire for each type of clams. The samples were shipped via a major courier service within several hours of packaging, and delivered to all recipients before noon the next day.
  - Nearly half of the 83 samples were sent to firms in the Northeast, and nearly one-third went to firms in the South. Only two firms in the Midwest agreed to evaluate samples; both were in the Chicago area. Approximately one-fifth of the samples were shipped to firms on the west coast. Despite the care and diligence exercised in gaining the cooperation of the shellfish dealers receiving samples, only 52 of the 83 provided completed product evaluations, even after several telephone follow-up calls.
  - The overwhelming majority of the sample recipients indicated that the samples arrived in excellent condition, although several said their samples were slightly too warm for optimum shellfish storage conditions. Respondents were asked whether or not they could detect an odor from the samples, and 60 percent could not. Of those that said they could detect an odor, a small minority described the odor as "slightly unpleasant".
  - Respondents were asked to rate the appearance of the shells using a zero to 10 rating scale where zero represented "very unattractive" and 10 "very attractive". Both species of ark clams received mediocre evaluations, with average ratings of approximately five. Critics complained of the black color and "fuzzy" or "furry" appearance. There was concern that cleaning would be time consuming and costly.
  - Meat color was evaluated using the same rating scale, and the attractiveness ratings fared worse than that of shell appearance, with average ratings of 4.2 for Blood Arks and only 3.6 for Ponderous Arks. A paired t-test indicated that the rating differences were statistically significant. Meat color ratings were heavily skewed towards the "very unattractive" end of the rating scale; nearly 15 percent of the
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- respondents gave a zero rating to Blood Arks, and 22 percent gave a zero rating to meat color of Ponderous Arks. Most comments made with respect to meat color were negative, criticizing the bloody appearance, but several were positive, stating the clam meat was “colorful” and “normal after cooking”.
- Respondents rated “taste” using a similar zero to 10 scale where zero represented “very poor” and 10 “extremely good”. Respondents were asked to rate taste if eaten raw, and also to rate taste if eaten cooked. Mean ratings were just under five for taste if eaten raw, and approximately five if eaten cooked. Taste ratings, whether eaten raw or cooked, were not statistically different for the two types of ark clams.
  - Texture was evaluated using a five-point semantic differential scale ranging from “much too tough” to “much too soft”, with the mid-point being “just right”. Fifty-five percent of the respondents said the Blood Arks were slightly or much too tough, and 60 percent described Ponderous Arks using these terms. Texture differences were not statistically significant for the two species of clams.
  - When asked how many of each of the two kinds of clams they could sell each week, just over half of the dealers said they could not sell any of the Blood Arks. About one-fifth of all respondents stated that they simply did not know how many they could sell. Eleven firms made positive sales projections, but these estimates were extremely variable, ranging from only 30 to 170,000 per week.
  - Sixty percent of the respondents felt they could not sell any Ponderous Ark clams. About one-fifth said they did not know how many they could sell. Only eight firms provided weekly sales estimates; their responses ranged from 30 to 120,000 clams.
  - When asked for general comments about the ark clam samples, numerous respondents said they had trouble cooking them. Comments were similar for both types of clams. Many said it took too long for them to cook; some said they never opened, and others said they were difficult to open, even when cooked.
  - Marketability issues were also mentioned by respondents; although many of the comments were negative, some were positive. Most positive comments reflected opinions that both types of ark clams had appeal to ethnic markets, primarily Asian consumers.
  - As to the potential marketability of these species, the product evaluations and many of the respondents’ comments indicate that these two species of ark clams are perceived as being too different from clams currently available on the market. These findings, coupled with shellfish dealers’ unwillingness to evaluate free samples leads us to conclude that it is unlikely that there will be widespread, mainstream demand for them.
  - Despite the overall negative tone of these findings, market development proponents should recognize the importance of ethnic markets in target locations on the East and West coasts. Targeting seafood dealers in these areas with large Asian and Hispanic populations could result in profitable niche markets.
  - **PHASE III:** Comprehensive nutritional analyses were conducted for the Blood Ark and the Ponderous Ark clams. Samples of cultured ark clams were collected from their respective growing areas near St. Augustine (east coast of Florida) and Cedar Key (west coast of Florida). An accredited private food-testing laboratory analyzed
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100g samples of raw edible portions of both species. Official methods of analysis were used following the AOAC (Association of Official Analytical Chemists) guidelines.

- Details of the nutritional analyses are found in Appendix D, Table 1. The Blood Ark sample was found to be relatively low in calories (35) and total fat (0.5g), but high in protein (7g). Cholesterol was relatively low (35 mg) and there was no detectable carbohydrate in the sample. The 100g sample provided relatively low daily values of vitamins A (6%) and C (2%), as well as calcium (6%). However, Blood Ark meats are high in iron, providing 70 percent of daily requirements. The sodium content was also quite high at 740 mg, which represents 31 percent of the daily value.
- Ponderous Ark clams were also found to be low in calories (5) and total fat (1.0g) and even higher in protein (11g). Cholesterol was higher than in Blood Arks at 55 mg, representing 18 percent of the daily value, but carbohydrate was quite low (1g). In terms of percent of daily value, a 100 g serving of Ponderous Ark clams provides 6% of Vitamin A, 4% of Vitamin C, and 10% of calcium. Ponderous Arks are also high in iron (50 percent of daily value). Sodium content is lower than in Blood Ark clams, but at 480 mg still relatively high, providing 20 percent of daily value.
- Comparisons of hard clam (*Mercenaria mercenaria*) values with those for the ark clams reveal the hard clam is slightly higher in calories and protein, but similar in total fats, cholesterol and carbohydrate. Ark clams provide two to three times more iron than hard clams, but they also provide ten times the amount of sodium, a concern for consumers that must restrict their intake of sodium.
- To determine the survival of the ark clam species in refrigerated storage (approximately 45°F), a shelf life evaluation was conducted. Clams were handled in accordance with accepted regulatory protocol during and after harvest. Approximately 90 percent of the Blood Ark clams survived 14 days, and by the 21<sup>st</sup> day, only 62 percent were alive. In contrast, 100 percent of the Ponderous Ark clams survived 22 days, and 99 percent were still alive when the experiment was terminated on Day 23.
- In summary, the current market for both Blood Ark and Ponderous Ark clams is very limited in the U.S. Very few certified shellfish dealers are currently selling them, probably less than one percent of all shellfish dealers. Further, there is widespread lack of familiarity with these species.
- Producer groups should work with the Division of Marketing of the Florida Department of Agriculture and Consumer Services (FDACS) to provide information about Blood Ark and Ponderous Ark clams to potential dealers at national seafood trade shows. Such information could also be incorporated into the FDACS website to foster greater knowledge in the trade and to arouse dealers' and consumers' curiosity. These promotional methods could serve as relatively inexpensive promotional tools.

## INTRODUCTION

Hard clams have been successfully cultured for commercial markets in Florida since the late 1970s (Sturmer), but the enactment and implementation of the net ban in 1994 provided the economic motivation for rapid industry expansion. The development of Florida's hard clam industry has proven to be mutually beneficial for fishermen adversely impacted by the net ban and clam farmers. The rapidly growing clam aquaculture industry has allowed fishermen to continue working on the water and has provided hard clam aquaculturists with an experienced labor force.

Since 1993, farm gate sales of aquacultured hard clams have increased from \$3.7 million to \$18.2 million in 2001 (Philippakos et al; Florida Agricultural Statistics Services [FASS]). In 2001, the Florida clam industry was comprised of 336 active growers; these clam farmers sold 142 million clams in 2001 at an average price of 11 cents each (FASS). All clams currently aquacultured in Florida are of the genus and species *Mercenaria mercenaria*.

The rapid growth of Florida's hard clam industry has motivated aquaculturists to explore alternative molluscan species. Production of additional species could reduce potential production risks and foster market expansion. By culturing only one species of clams, the industry is exposed to potential production risks. For example, if *Mercenaria mercenaria* were particularly susceptible to a rare disease and an outbreak occurred in Florida's major clam production areas, severe economic losses could result. Diversity of species could possibly provide some degree of protection against such catastrophic losses. A second reason to explore production of other molluscan species is to offer consumers more choices, possibly increasing clam producers' total sales and profitability. Two possible species for production and marketing diversity are the Blood Ark (*Anadara ovalis*) and the Ponderous Ark (*Noetia ponderosa*).

In the United States, Blood Arks can be found from Cape Cod, Massachusetts to Texas and the Caribbean to Brazil. The Ponderous Ark is found from Virginia to Florida and from the Florida Keys to Texas (Abbott). Wild stocks of the Blood Ark and Ponderous Ark clams are currently harvested on a limited basis for ethnic markets in the United States. The development of a major fishery for these species has been limited by a variety of factors. These factors include dispersed wild ark clam populations, limited understanding of clam reproduction, and relatively small, isolated ethnic markets. Until recently, these clams have been largely overlooked by the shellfish and fishing industries.

In the mid-1980s, a marketing survey of seafood dealers in the United States and abroad (interested members of the shellfish trade received samples of live ark clams for evaluation) failed to produce evidence of viable markets (Anderson et al. 1984, Anderson and Eversole, 1985). Far Eastern markets proved to be most familiar with these clams, but their local supplies were more than adequate, and prices were depressed. Low prices, market saturation, and transportation logistics effectively eliminated the potential for these clams to be marketed in the Far East.



Even though small commercial markets were being developed in the U.S. in the early to mid 1980s, Anderson and his colleagues concluded from their studies that large investments of time and money would be required to develop larger scale, successful markets for these clams.

Despite their relatively pessimistic conclusions at that time, several factors have emerged that give a glimmer of optimism for the possibility of developing larger domestic markets for ark clams. One of the most significant factors is the continued growth of Hispanic and Asian populations, demographic segments that are more likely to have some degree of familiarity with ark clams.

Another positive factor is that a small fishery for arks, primarily the Blood Ark and the Ponderous Ark, has continued to develop (mostly in Virginia) with landings reported since 1993. Ark landings in the United States ranged in value from \$30,300 in 1995 to \$136,480 in 1997. Arks are sold primarily as an ethnic food in Chicago, New York, Los Angeles, and Washington D.C. or exported to Mexico (McGraw et al.), where an Ark fishery has been in existence for many years. Anecdotal information indicates the demand for Arks has outpaced the numbers that can be supplied by the Virginia fishery. Industry professionals feel this increase in demand is in part due to increasing ethnic markets that value the presence of hemoglobin in the clam meats. The presence of the blood pigment hemoglobin results in the ark clam's characteristic orange coloration (Shirley Estes, Executive Director, Virginia Marine Products Board, Newport News, VA, personal communication).

## **OBJECTIVES**

This research quantifies the shellfish trade's present awareness and acceptance of the Blood Ark (*Anadara ovalis*) and Ponderous Ark (*Noetia ponderosa*) clams. The basic objective of this study was to determine the current market potential of Blood Ark and Ponderous Ark clams in the U.S. Specific objectives were to:

- Assess the magnitude of the current and potential domestic market for both types of ark clams.
- Determine product attributes desired by the shellfish trade, especially size, meat color, shell appearance, and taste.
- Educate shellfish wholesale dealers as to the market attributes of these alternative molluscan shellfish species.
- Determine physical characteristics of the clams, specifically shelf life and nutritional analyses.

In order to achieve these objectives, the study was conducted in three phases. The first was a nationwide census of all certified shellfish dealers. The major focus of this phase was to assess the current market situation for the two types of clams, including the trade's knowledge levels about them and attitudes toward handling Blood Ark and Ponderous Ark clams if adequate supplies were forthcoming. Phase I identified shellfish dealers that were

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willing to evaluate samples of both types of ark clams that were to be aquacultured in Florida.

In Phase II, the firms identified in Phase I as potential marketers of Blood Ark and Ponderous Ark clams were provided live samples for evaluation. Representatives of these firms were asked to evaluate a number of basic product characteristics, including appearance and organoleptic qualities. They were also asked to estimate potential sales through their respective firms.

Phase III determined the shelf-life under typical commercial refrigeration and the nutritional composition of each species.

## PROCEDURE

### Phase I Procedure

Because of budget constraints and the anticipated low incidence of familiarity with Blood Ark and Ponderous Ark clams, a mail survey was selected as the primary data collection method. The questionnaire was developed in consultation with several marine extension specialists and University of Florida researchers. The questionnaire was pre-tested with extension marine specialists, and after minor modifications submitted to the Institutional Review Board of the University of Florida, where it was approved.

The questionnaire was designed to have a parallel structure for both the Blood Ark clams and the Ponderous Ark clams. That is, after questions were asked about Blood Ark clams, similar questions were asked about Ponderous Ark clams. In a concluding section, there were general questions about the firm's sales in 2001 and respondents' willingness to evaluate live samples of both types of clams (Appendix A).

The questionnaire was sent via first class U.S. mail to all firms on the Interstate Certified Shellfish Shippers List. This list is maintained by the U.S. Food and Drug Administration and included all U.S. firms certified to ship molluscan shellfish. The list constituted a complete enumeration of shellfish dealers in the United States, thus a complete canvass was conducted. The initial mailing of a cover letter, informed consent document, the questionnaire and a business reply envelope was sent to 2,133 firms. This mailing was made in October 2002. Two weeks after the initial mailing, a reminder post card was sent to all non-respondents.

Two versions of the cover letter were utilized in the initial mailing of the questionnaires, with half of the firms receiving one version, and the other half the second. Firms receiving the first version could only respond via U.S. mail. With the second version, the firm had the option of responding by either the Internet or mail. This was done to determine if the choice of response options would increase the overall response rate. The firms given the option of completing the questionnaire via the Internet received unique username-password combinations to allow access to the survey website and preclude multiple responses. Offering respondents the option of responding via the Internet had virtually no effect on the overall response rate.



Response rates from the initial mail survey were below expectations; therefore, a systematic random sample comprised of ten percent of the non-respondents was selected for telephone follow-up interviews. This procedure was used to determine if responses of non-respondents were similar to those of the respondents. A sample of 180 non-respondents was contacted by telephone in January 2003 and 96 usable responses obtained. The removal of 285 questionnaires deemed undeliverable by the United States Postal Service reduced the reachable universe of certified shellfish dealers to 1,848. In total, 309 (16.7 percent) complete questionnaires were recorded and comprised the final database (Table 1). Of these, 206 (66.6 percent) arrived via postage-paid business reply envelopes provided in the original mailed packet. Another 96 (31.1 percent) firms were contacted and successfully interviewed via telephone. Additionally, seven firms (2.3 percent) responded via the online version of the questionnaire.

Table 1. Disposition of Mailed Questionnaires and Response Rates, Phase I.

Description of items mailed and returned	Number	Percent
	----n----	----%----
Total questionnaires mailed	2,133	100.0
Undeliverable	285	13.4
<b>Total questionnaires delivered</b>	<b>1,848</b>	<b>86.6</b>
Questionnaires returned by mail	206	66.6
Questionnaires completed via telephone	96	31.1
Questionnaires completed via Internet	7	2.3
<b>Usable questionnaires</b>	<b>309</b>	<b>100.0</b>
Estimated number of eligible respondents	1,848	100.0
Adjusted response rate	-----	16.7

Due to the limited numbers of responses dealing with the familiarity and sales experience of both types of ark clams, commonly used statistical tests such as Chi-square, logit and probit analyses could not be administered with confidence. The responses of the mail, phone and Internet respondents appeared similar upon inspection, and were analyzed and discussed as one sample population. The apparent similarities in responses of those answering by mail and responses from the telephone follow-up interviews lead us to conclude that, despite the relatively low overall response rate, the findings from our sample are representative of the entire shellfish industry.

**Phase II Procedure**

The procedure for Phase II, distribution and evaluation of live samples of aquacultured Blood Ark and Ponderous Ark clams, is discussed in this section. Samples of both ark clams were harvested from approved shellfish waters in mid-November, and held overnight in a refrigerated facility owned by a certified shellfish processor in Cedar Key, Florida. Harvesting, processing and refrigerated storage procedures followed the state shellfish regulations administered by the Florida Department of Agriculture and Consumer Services (FL Administrative Code, Chapter 5L-1). About noon the next day, a sample of 6 Blood Arks, ranging in size from medium to large, and a combined sample of 9 medium and 6 large Ponderous Arks were placed in separate small, color-coded plastic mesh bags with the processor's dealer tags affixed to each bag. One bag of each ark clam species was placed in an insulated shipping container made of expanded polystyrene foam along with a frozen 8-ounce gel pack. The foam shipper containing the two bags of clams and gel pack was then placed inside a corrugated cardboard container measuring 6"x 8"x 4". Evaluation instructions for the respondents and a one-page questionnaire (Appendix B) for each ark clam sample were conspicuously placed inside the corrugated box, which was then sealed and labeled for shipping. The samples were picked up by a major courier service within several hours of packaging, and delivered to all recipients before noon the next day.

The 97 firms that had initially agreed to evaluate live samples of Blood Ark and Ponderous Ark clams were contacted in early November 2003 to confirm their willingness to participate in the study. Letters were sent to them, and follow-up phone calls were made. When contacted by telephone, 14 firms refused to participate or had disconnected phones, so samples were not sent to them. Thus, a total of 83 samples were distributed nationwide for evaluation.

**Phase III Procedure**

Comprehensive nutritional analyses were conducted for both clam species. Samples were collected from their respective growing areas in St. Augustine (east coast of Florida) and Cedar Key (west coast of Florida). One hundred gram samples of meat (wet weight) were shucked for each ark clam species and delivered in coolers to an accredited private food-testing laboratory in Gainesville. Official methods were used following the AOAC (Association of Official Analytical Chemists) Official Methods of Analysis (Horwitz, 2002).

To determine the survival of these two ark clam species in refrigerated storage, evaluation of shelf life was conducted in April 2004. Procedures followed those developed by Applewhite et al. (1996) and Otwell (1998) for determining shelf life of hard clams *Mercenaria mercenaria*. The ark clams were checked daily for survival with the exception of two days during the evaluation period. Gapped ark clams were determined to be "commercially dead" when they did not respond by closing their shell to specified agitation, or tapping, after the ark clams were held for a short time at room temperature. Dead ark clams were counted and removed from the sample bags. The evaluation was conducted until 50 percent of the ark clams died. Percent survival for each ark clam



species was determined. Additional Phase III procedural details, findings and conclusions are found in Appendices D and E.

**PHASE I FINDINGS: THE CURRENT MARKET SITUATION**

**Blood Ark Clams**

Among certified shellfish shippers that responded to the survey, 91.9 percent have had no experience with the Blood Ark clam. Less than four percent have seen the clams at trade shows, and less than two percent have sold the clams in the past (Table 2). With a mere one percent of respondent firms currently selling Blood Ark clams, it is apparent that market exposure in the U.S. is extremely limited.

Table 2. Awareness of Blood Ark Clams Among Certified Shellfish Shippers.

Awareness Levels	Number	Percent
	---n---	---%---
No experience	284	91.9
Have seen at trade shows	11	3.6
Sold in the past	5	1.6
Currently selling	4	1.3
No response	5	1.6
Total	309	100.0

Of the small number of dealers that have previously sold Blood Ark clams, two, or 40 percent, do not currently offer the product due to insufficient market demand (Table 3). One respondent indicated that difficulties with product supply led him to discontinue clam sales. Additional reasons given for terminating sales of Blood Arks included a need for better product quality and a preference for farm raised clams.

Table 3. Reasons Why Previous Blood Ark Clam Dealers Are NOT Currently Selling Clams.

Reason	Number	Percent <sup>a</sup>
	---n---	---%---
Not enough consumer demand	2	40.0
Supply problems	2	40.0
Poor quality	1	20.0
Need farm raised	1	20.0
Don't know	1	20.0

<sup>a</sup>Total does not sum to 100.0% because of multiple responses.

## Shellfish Industry Survey

Analysis of current sellers of Blood Ark clams by firm size (as indicated by 2001 sales) revealed one was a Florida-based firm with sales in the \$1,000,000 to \$4,999,999 range (Table 4). Two firms had sales in the range of \$100,000 to \$499,999 and were located in Virginia and California. A fourth firm located in California did not reveal total 2001 sales.

Table 4. Locations and Size Categories of Firms Currently Selling Blood Ark Clams.

State	Number	Percent of Respondents	Annual 2001 Sales
	---n---	---%---	
Florida	1	25.0	\$1,000,000 to \$4,999,999
Virginia	1	25.0	\$100,000 to \$499,999
California	1	25.0	\$100,000 to \$499,999
California	1	25.0	N/A

The majority of current sellers obtained their clams from the East coast of the United States (Table 5). In particular, two shippers obtained their clams from North Carolina, which accounted for 50 percent of respondents' sources. Virginia and "Asia" were also cited as Blood Ark clam sources, with Asian supplies available as frozen product only.

Table 5. Current Sellers' Geographic Sources of Blood Ark Clams.

Blood Ark Clam Sources	Number	Percent of Respondents
	---n---	---%---
North Carolina	2	50.0
Virginia	1	25.0
Asia	1	25.0
Total	4	100.0

Current sellers indicated that the majority of their clams are shipped to U.S. East coast destinations, specifically to New York and Washington, D.C. (Table 6). One respondent had supplied Blood Ark clams to California markets. The reported volume of Blood Ark clams sold was extremely variable and very limited. Two of the four firms that sold the clams in 2001 reported annual sales of 16,000 and 1,000 clams, respectively (Table 7). Three-fourths of the clams sourced from Virginia were sold primarily in the winter months, with the remainder purchased in the fall months.

Shellfish shippers that reported 2001 sales of Blood Ark clams were queried on prices paid for the product and their perceptions of overall product quality from their major suppliers. One respondent indicated a range from a high of \$0.25 per clam to a low of \$0.18 for an average price of \$0.22 per clam. When asked to rate the quality of the Blood



Ark clams using a rating scale where 1=very poor and 10=excellent, North Carolina clams received a rating of “9”, while Virginia clams were assigned a perfect “10” value.

Table 6. Current Sellers’ Destination Markets for Blood Ark Clams.

Blood Ark Clam Destination Markets	Number	Percent of Respondents
	---n---	---%---
New York	2	50.0
Washington, D.C.	1	25.0
California	1	25.0
Total	4	100.0

Table 7. Number of Blood Ark Clams Sold in 2001 to Current Destination Markets.

Blood Ark Clam Destination Markets	Number of Clams Sold	Percent
	---n---	---%---
New York	16,000	94.1
Washington, D.C.	1,000	5.9
California	N/a	n/a
Total for responding firms	17,000	100.0

Current sellers were asked for suggestions as to how clam producers could increase retail sales. Three recommendations were proposed: “Get more Blood Ark clams”, “Identify biomass producing areas”, and “Increase supply, so it is not a limiting factor”. Inadequate supplies appear to be a significant limitation to market growth at present.

The majority of outlets that purchased Blood Ark clams are wholesalers followed by specialty seafood retailers and large retail grocers. Clam buyers noted that Hispanics characterized the primary ethnic market for this clam, with consumers of Asian descent representing a viable secondary target market.

The average shelf life of fresh Blood Ark clams was reported to be 15 days. Two respondent firms preferred the largest available size of Blood Ark Clams, defined as an average 1.25 inches in shell width, 1.75 inches in shell length (long), and approximately 13 clams per pound. A third dealer favored the medium size clam, with an average width of one inch, length of 1.5 inches, and 20 clams per pound. None of the firms ranked clams described as “Small” (Average ¾ inch wide, 1¼ inches long, 34 clams/pound) as either a first or second choice. Firms were queried on their assessments of an ideal Blood Ark clam meat color, and responses included either a light or medium color, or no preference between light, medium or dark meats.

## Shellfish Industry Survey

### Ponderous Ark Clams

Among certified shellfish shippers that responded to the questionnaire, nearly 97 percent have had no experience with the clam, less than two percent have seen the clams at trade shows, and only one percent has sold the clams in the past (Table 8). With only one respondent firm currently selling the Ponderous Ark Clam, market exposure is presently extremely limited. One previous Ponderous Ark clam dealer claimed that customers had not recently requested the product, so sales had been discontinued.

Table 8. Certified Shellfish Shippers' Awareness of Ponderous Ark Clams.

Awareness Levels	Number	Percent
	---n---	---%---
No experience	280	96.6
Have seen at trade shows	6	2.1
Sold in the past	3	1.0
Currently selling	1	0.3
Total	290	100.0

The sole Virginia firm that actively marketed Ponderous Ark clams in 2001 was relatively small, reporting total annual 2001 company sales in the \$100,000 to \$499,999 range. This current seller obtained Ponderous Ark clams primarily from the Virginia coast, and sold 100 percent of his volume, 4,000 clams in total, to markets in the Washington, D. C. metro area. Three-fourths of the clams sourced from Virginia were sold primarily in the winter months, with the remainder purchased in the fall.

The shellfish shipper that reported 2001 sales of Ponderous Ark clams was queried on prices paid for the product and his perceptions of overall product quality from his suppliers. This respondent indicated a range from a high of \$0.25 per clam to a low of \$0.18 received per clam, for an average price of about \$0.22 per clam. When asked to rate the quality of the Ponderous Ark clams using a rating scale where 1=very poor and 10=excellent, this firm assigned an overall rating of "9" to the product. The average shelf life of fresh Ponderous Ark clams was reported to be 15 days, and clam shell size and meat color preferences were not specified.

According to the lone respondent that sold this clam species in 2001, the predominant types of outlets that purchased Ponderous Arks were wholesalers and specialty seafood retailers. This clam dealer also noted that Hispanic and Asian ethnic groups represented typical Ponderous Ark clam consumers. The current seller proposed identification of biomass producing areas and an increase in clam production as a way of stabilizing supplies, which he/she felt would increase consumption.



## **PHASE I CONCLUSIONS: RESULTS FROM SHELLFISH DEALERS' SURVEY**

This research indicated that the present market for the Blood Ark and Ponderous Ark clams is extremely limited, due to limited trade knowledge of the product and inconsistent supply at the producer and consumer levels. If the respondents to our mail survey were representative of the entire universe of certified shellfish dealers in the U.S., it was estimated that only 24 were selling Blood Ark clams and only six were selling Ponderous Ark clams in 2001. However, projecting results of the usable responses to the universe probably overstates the true numbers of firms handling these two ark clams because the telephone interviews of nearly 100 non-respondents revealed no firms handling either of the ark clams.

In order to develop a domestic market for Blood Ark and Ponderous Ark clams, an aggressive educational program targeting the shellfish trade and ethnic consumers will be required. These results are virtually identical to those reached by a previous study which concluded that extensive expenditures of time and money would be required to expand demand for these clams (Anderson, et. al., 1985).

A few of the firms that did not report 2001 sales of Blood Ark or Ponderous Ark clams offered some insight into the marketing dilemma facing producers of these clams. For example, a few mentioned that a sluggish U.S. economy since the September 11, 2001 terrorist attacks has depressed seafood sales in general. Equal numbers of respondents mentioned the lack of consistent supply and quality of the available clams, limited market outlets and virtually nonexistent consumer demand.

On a positive note, some shellfish shippers indicated an interest in learning more about these clam types. Nearly one-third of all survey respondents indicated a willingness to evaluate samples of Blood Ark or Ponderous Ark clams. Out of 309 respondents, 97 provided mailing address information and requested Blood Ark clam samples, and 96 gave contact information in order to receive Ponderous Ark clam samples.

## **PHASE II FINDINGS: SHELLFISH SHIPPERS' EVALUATIONS OF BLOOD ARK AND PONDEROUS ARK CLAM SAMPLES**

### **Geographic Distribution of the Samples**

Nearly half of the samples were sent to firms in the Northeast, and nearly one-third went to firms in the South (Table 9). Only two firms in the Midwest agreed to evaluate samples; both were in the Chicago area. Approximately one-fifth of the samples were shipped to firms on the West coast. Despite the care and diligence exercised in gaining the cooperation of the shellfish dealers receiving samples, only 52 of the 83 provided completed product evaluations. Several telephone follow-up calls were made to non-respondents without success. For most regions, the response rate was approximately 60 percent, but slightly higher in Southern states (Table 9).

**Shellfish Industry Survey**

Table 9. Destinations of Samples and Response Rates, by U. S. Region, Phase II.

U. S. Region	Number of Samples Shipped		Number of Questionnaires Returned		Response Rate
	--- n ---	--- % ---	--- n ---	--- % --	
Northeast <sup>a</sup>	38	45.8	23	44.2	60.5
South <sup>b</sup>	26	31.3	18	34.6	69.2
Midwest <sup>c</sup>	2	2.4	1	2.0	50.0
West <sup>d</sup>	17	20.5	10	19.2	58.8
Total	83	100.0	52	100.0	62.6

<sup>a</sup> Northeast – Maine, Connecticut, New York, New Jersey, New Hampshire, Rhode Island, Pennsylvania, Massachusetts <sup>b</sup> South – Louisiana, Alabama, Florida, Georgia, North Carolina, South Carolina, Virginia, Maryland, Delaware <sup>c</sup> Midwest – Illinois <sup>d</sup> West – California, Washington, Oregon

**Blood Ark Clams**
Arrival Condition of Blood Ark Clam Samples

Respondents were instructed to immediately refrigerate the samples upon arrival and evaluate the same day. While most respondents evaluated the samples the day of arrival (the third day after harvest) there were a few firms that waited several days before evaluating the samples and completing the questionnaires. Although there were not enough observations to conduct a statistical test of the relationships between respondents' evaluation dates and ratings for arrival condition, examination of the arrival condition ratings for the "late" evaluators compared with those evaluating the clams immediately upon arrival revealed no appreciable differences.

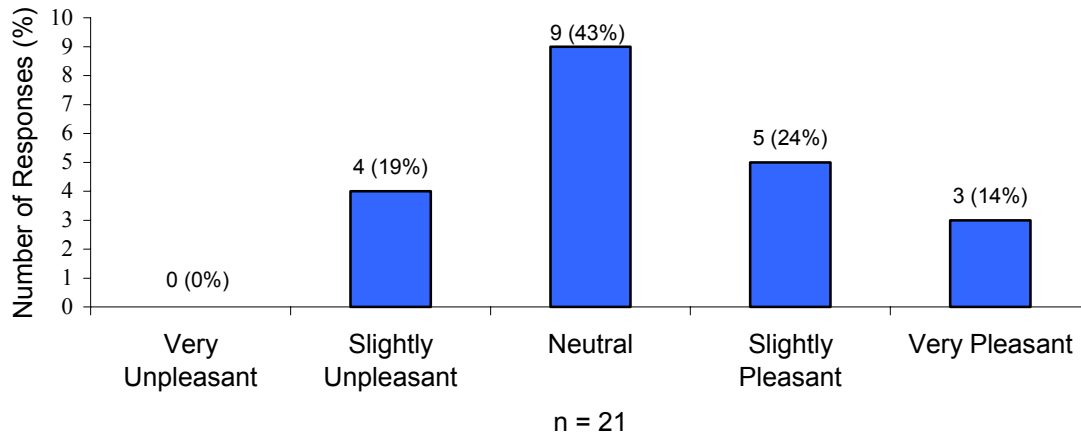
Each questionnaire began with several questions to determine the arrival condition of the samples. The first question asked whether or not the evaluator could detect an odor, the rationale being that shellfish arriving in poor condition would have a strong, unpleasant odor. Approximately 60 percent were unable to detect any odor (Table 10). Of the remaining 40 percent (21 observations), only four described the detected odor as "slightly unpleasant" while nine described the odor as "neutral", five described it as "slightly pleasant" and three described it as "very pleasant" (Figure 1).

Table 10. Respondents' Detection of Odor in Blood Ark Clams.

Blood Ark Clam Odor	Number	Percent
	----- n -----	----- % -----
Able to detect an odor	21	40.4
Unable to detect an odor	31	59.6
Total	52	100.0



Figure 1. Description of Odor for Blood Ark Clams.



In addition to asking about the odor of the clams, respondents were also asked to evaluate “overall arrival condition” on a zero to ten scale where zero represented “extremely poor” and ten represented “extremely good”. The mean rating for this evaluation was 9.4 (Table 11). Examination of the few less-than-perfect ratings revealed a concern that several samples had arrived slightly too warm for optimum shellfish storage (Appendix B, Table 1).

Table 11. Evaluations of Arrival Condition, Shell Appearance, and Meat Color for Blood Ark Clams.

Attribute	Number		Mean Rating	Standard Deviation
	--- n ---	--- % ---		
Arrival Condition <sup>a</sup>	51	98.1	9.4	1.2
Shell Appearance <sup>b</sup>	51	98.1	5.2	2.9
Meat Color <sup>b</sup>	47	90.4	4.2	3.0

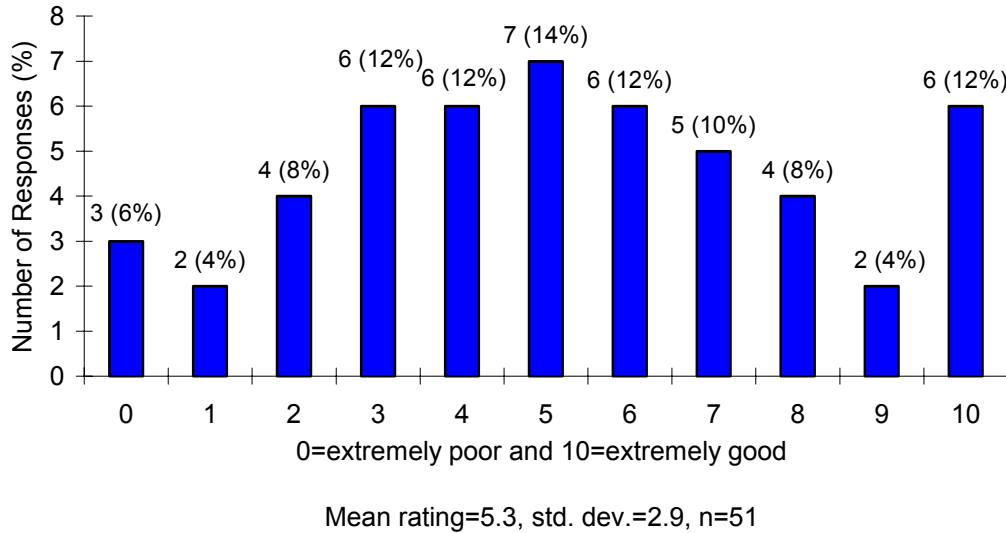
<sup>a</sup> Rating Scale of 0 to 10 was defined for arrival condition as 0 = extremely poor, 10 = extremely good. <sup>b</sup> Rating Scale of 0 to 10 was defined for shell appearance and meat color as 0 = very unattractive, 10 = very attractive.

### Evaluation of Blood Ark Clams’ Shell Appearance

The Blood Ark clamshell is covered with a thick dark brown or black periostracum, which is a fibrous noncalcareous covering. Exterior shell appearance was also evaluated using a zero to ten rating scale where zero represented “very unattractive” and ten represented “very attractive”. The mean rating was 5.2, with a standard deviation of 2.9 (Table 11). The majority of the evaluations were clustered in the mid-point of the scale, but nearly 12 percent rated the shell appearance a perfect “10” (Figure 2). Nearly 20 percent rated the shell appearance as a “2” or lower.

## Shellfish Industry Survey

Figure 2. Blood Ark Clam Shell Appearance Ratings.



Respondents made a few negative comments about the shell appearance, but no favorable comments. Negative statements included “should have a cleaner shell to steam”, “black fuzz needs to be removed”, “hard to clean organic material off shell”, “hairy cover not likeable”, “shell stock looked good except for moss growth on shell”, “fuzzy, dirty appearance not desirable in this area”, and “I would want to scrub before serving—looks like not super sanitary” (Appendix C, Table 1).

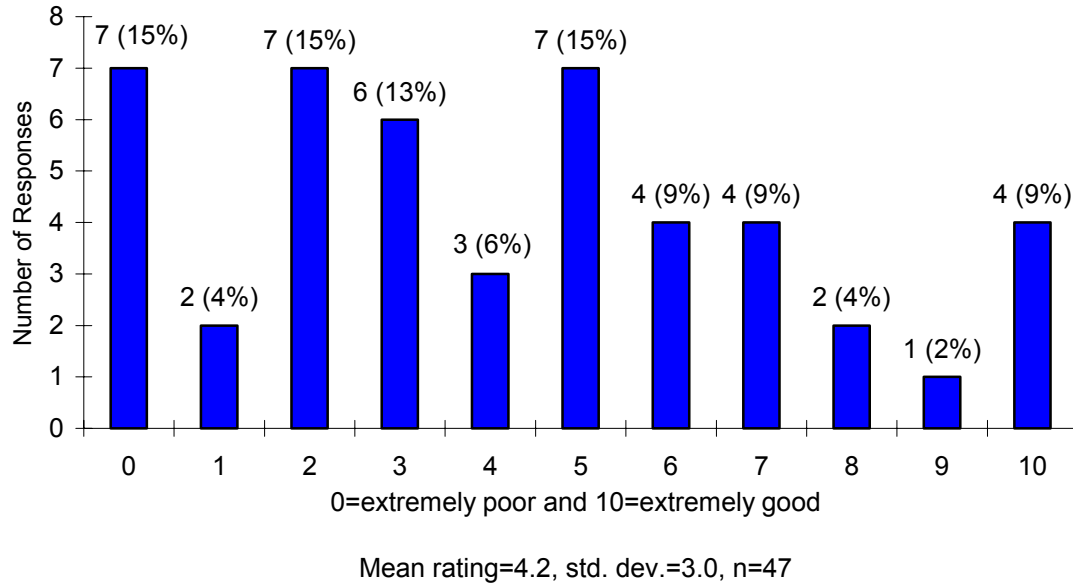
### Evaluation of Blood Ark Clams’ Meat Color

Both ark clam species contain the blood pigment hemoglobin, which gives the meat an orange to red coloration. Respondents were asked to rate the attractiveness of the Blood Ark clam meat color using the same zero to ten scale where zero represented “very unattractive” and ten represented “very attractive”. The mean rating was 4.2, with a standard deviation of 3.0. The ratings were skewed to the negative end of the scale; nearly 15 percent rated the meat color as a zero, or “very unattractive”. About one third of all respondents rated meat color as a “2” or below (Figure 3).

Most of the comments respondents made about the meat color were negative. Examples of negative comments include “bad, bad, gross”, “ugly meat”, “blood appearance borders on unappealing”, and “looks like raw liver”. A few comments were slightly more forgiving: “raw ugly—cooked normal”, “as far as these animals go, meat (color) is acceptable”, and “these are very colorful compared to other shellfish” (Appendix C, Table 1).



Figure 3. Blood Ark Clam Meat Color Ratings.



Blood Ark Clam Serving Methods and Taste Evaluations

Respondents were allowed the flexibility of serving the Blood Ark clam samples raw, cooked, or both. They were asked to evaluate the taste for each way served. Half of the respondents served them raw, and 42 of the 52 served them cooked (Table 12). Twenty-two respondents sampled them both ways, raw and cooked.

Table 12. Taste Ratings by Serving Method for Blood Ark Clams.

Serving Method	Number	Mean Rating <sup>a</sup>	Standard Deviation
Raw	26	4.8	2.5
Cooked	42	4.9	2.9

<sup>a</sup> Rating Scale of 0 to 10 was defined as 0 = very poor, 10 = extremely good.

Respondents were asked to rate taste for each cooking method using a zero to ten scale where zero represented “very poor” and ten represented “very good”. Mean ratings were less than stellar; the mean ratings for Blood Ark clams were 4.8 and 4.9 for those eaten raw and cooked, respectively (Table 12). A paired-t test (testing the differences between cooked and raw ratings) showed the mean taste rating difference between cooked Blood Ark clams to be 0.50, with a t-value of 1.14, which was not statistically significant at the 0.05 probability level.

Respondents that cooked the clam samples were asked to indicate the cooking method used, and thirty-two of the 42 respondents did so. Of those reporting the cooking

## Shellfish Industry Survey

method used, the overwhelming majority, 84 percent, steamed them. Smaller numbers said they microwaved or baked them (Table 13, Figure 4). When the ratings were examined by cooking method, the rating for taste when steamed was 4.3, but it was 5.7 for those that were microwaved and 7.0 for those baked. However, there were too few observations to statistically test this relationship (Table 13).

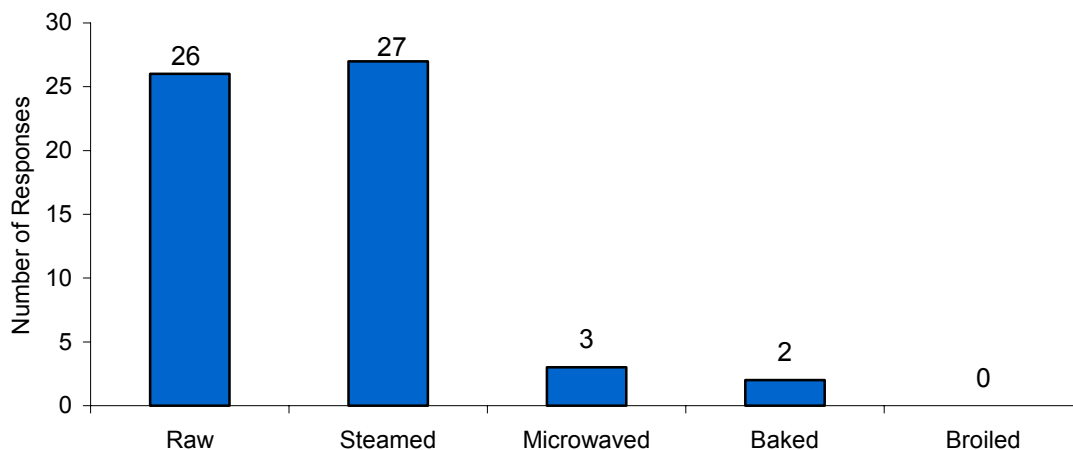
Table 13. Cooking Methods and Taste Evaluations for Blood Ark Clams.

Cooking Method	Number	Percent	Mean Rating <sup>a</sup>	Standard Deviation
	-----n-----	-----%-----		
Steamed	27	84.4	4.3	3.0
Microwaved	3	9.4	5.7	2.1
Baked	2	6.2	7.0	0.0
Total	32	100.0	4.9	2.9

<sup>a</sup> Rating Scale of 0 to 10 was defined as 0 = very poor, 10 = extremely good.

Comments about Blood Ark clams' taste were mixed, with positive and negative reactions about equal in number. Positive comments included "OK taste", "good flavor", "different taste", "very good flavor", and "excellent taste and presentation". Negative statements tended to focus on bitterness and strong flavor. Comments included "taste was bitter", "they suck raw", "rather bitter", and several said "much too strong flavor". Several respondents said they could not comment on the taste because the clam did not open, despite extended steaming times (Appendix C, Table 1).

Figure 4. Blood Ark Clam Serving Methods Used by Respondents.





Texture Ratings for Blood Ark Clams

Respondents were asked to rate the texture of the Blood Ark clams using a five-point semantic differential scale. The five points were defined as “much too tough”, “slightly too tough”, “just right”, “slightly too soft”, and “much too soft”. Of the 45 respondents that answered this question, 13 percent said they were much too tough, and 42 percent said they were slightly too tough. Thirty-eight percent said they were just right, and 7 percent indicated that they were slightly too soft. No one said they were much too soft. Thus, one can conclude that the overall texture was judged to be somewhat tougher than ideal (Figure 5).

Respondents made positive and negative comments about the clam texture. On the positive side one said “good texture”, and another said “good flavor and texture”. Most comments were negative. Negative statements included “the clams were rubbery, but OK taste”, “texture was very poor”, and “I found the clams to be tender, but still full of too much liquid to say I honestly liked their texture. Even after waiting for a ‘drying out period’ after initial steaming, I still found them ‘visceral’. Too many thin, skinny membranes to be chewed and swallowed”.

Size Preferences for Blood Ark Clams

The clams included in the sample of Blood Ark clams ranged in sizes that would generally be classified as “medium” to “large”. The sample size averaged 1  $\frac{3}{4}$ ” in shell length, 1  $\frac{1}{5}$ ” in shell width and 15 per pound. When asked which size would be most popular in their market area, approximately one-fifth of the respondents were uncertain. Of those that expressed an opinion, slightly less than one-fifth felt the medium-sized clam would be more popular, and slightly over one-third felt the large-sized clams would be preferred. Nearly half of the respondents felt that either would be acceptable (Figure 6).

### Shellfish Industry Survey

Figure 5. Blood Ark Clam Texture Ratings.

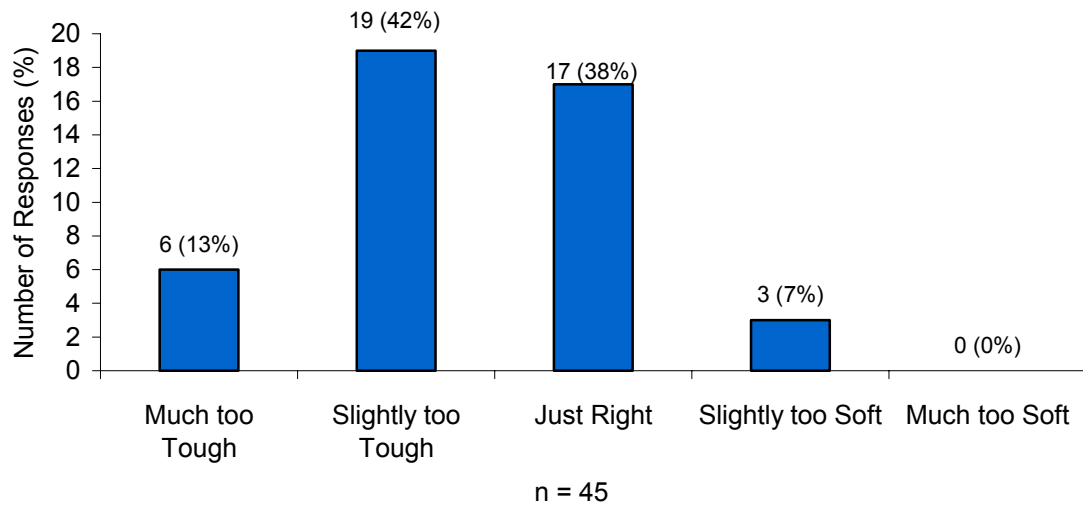
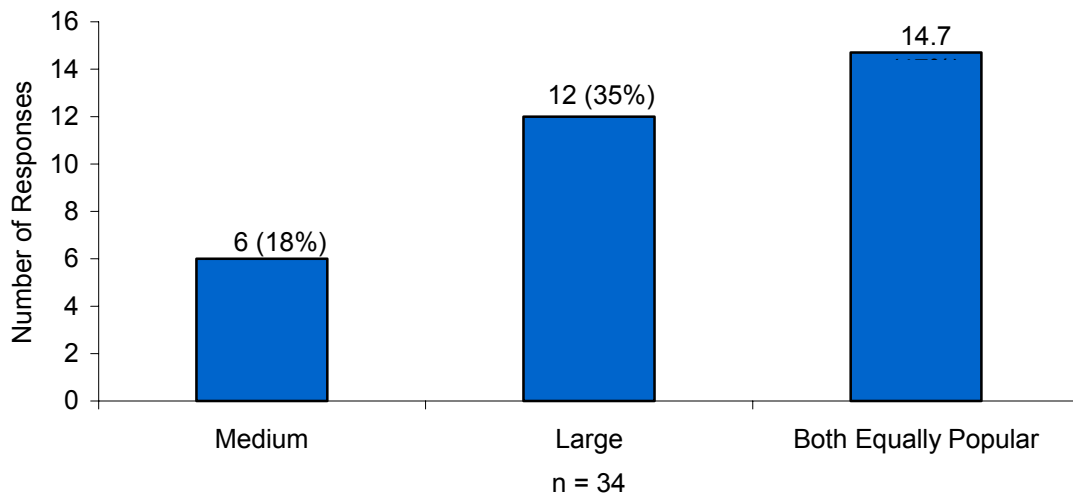


Figure 6. Most Popular Blood Ark Clam Size.





Estimated Weekly Sales Of Blood Ark Clams

Respondents were asked how many Blood Ark clams their firms could sell each week, if any, assuming that they were available on a year-round basis at prices “comparable to hard clams from Florida”. Of the 41 respondents that answered this question, slightly over half said “none”. Twenty-two percent indicated that they could probably sell some, but would not provide an estimate, and 11 firms provided estimates (Table 14).

Table 14. Estimated Weekly Sales of Blood Ark Clams.

Estimated Weekly Sales	Number	Percent
	-----n-----	-----%-----
Number reporting a positive value	11	26.8
Don't know	9	22.0
None	20	51.2
Total	52	100.0

Sales estimates provided by the 11 firms were extremely variable, ranging from 30 to 170,000 clams per week. The mean estimated clam sales figure for the 11 firms was just over 20,500 clams per week per firm, but given the extreme variability of the estimates, the mean is of little value. Out of the total estimated weekly Blood Ark clam sales of approximately 226,000 animals, one west coast firm’s estimate accounted for 170,000. Five of the 11 firms estimated that their Blood Ark clam sales would be 1,000 or fewer; three additional firms’ estimates ranged from 2,000 to 10,000 per week, and only three respondents thought they could sell more than 10,000 per week. Estimated sales were analyzed on a regional basis, and found to be extremely variable as well. Sales estimates in the Northeast ranged from 1,000 to 17,000 clams per week; in the South, estimates ranged from 50 to 20,000 per week, and in the West from 30 to 170,000 clams (Table 15).

Table 15. Ranges of Estimated Weekly Sales of Blood Ark Clams, by U. S. Region.

Region	Number of Firms	Number of Clams Sold
	-----n-----	-----n-----
Northeast	4	1,000 – 17,000
South	4	50 – 20,000
Midwest	0	--
West	3	30 – 170,000
Total	11	30 – 170,000

## Shellfish Industry Survey

### General Observations on Blood Ark Clams

#### *Cooking Problems*

Several respondents complained about the difficulties associated with cooking the Blood Ark clams, and most dealt with lengthy cooking times and difficulties of opening. Respondents' comments included "...only one clam opened after 15 minutes of steaming", "did not open as quickly [as other types of clams]", "they would not open—could not eat", and "hard to open with a knife".

#### *Marketability*

When asked for general reactions to the Blood Ark clams, many commented on their potential marketability, and opinions were mixed. Many respondents dismissed them with comments such as "not saleable in this area", and "overall attitude from samplers was 'GROSS'". One dealer put it slightly more eloquently "In comparison to many fine clams available on the West coast, which are attractive, easy to cook, and very tasty with a sweeter flavor, we do not feel these clams would be marketable in our marketing area". One dealer also took issue with their name, saying "Blood Ark" is a "bad name".

Despite the negative reactions by many of the respondents, a few were more charitable and several were even quite positive. Several dealers indicated current interest in selling these clams. They remarked "[Blood Ark clams will be] very good in the future market. Let me know when the clams are available", and "Glad to see them—have customers with interest". Another semi-positive comment was "If they were cheap enough, people may buy them". Several expressed the opinion that the Blood Ark clams would have greatest appeal to ethnic populations, primarily Asians. This opinion was expressed best by one dealer that stated "This type of clam would only be of interest to certain ethnic groups. However, if you went after these specific markets, this clam could be successful".



**Ponderous Ark Clams**

Arrival Condition of the Ponderous Ark Clams

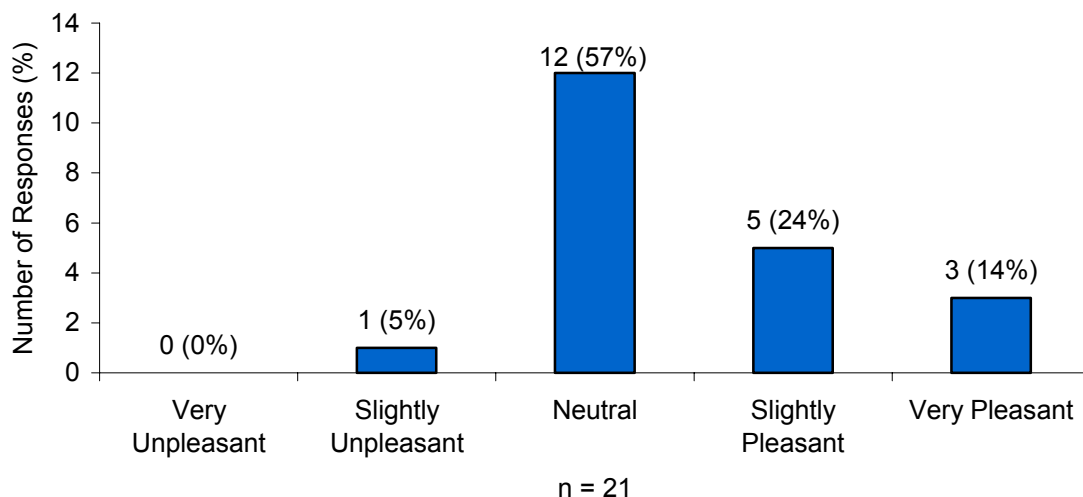
Because the Blood Ark and Ponderous Ark clam samples were harvested on the same day, stored overnight in the same certified shellfish facility, and packed and shipped in the same box, it was expected that the arrival condition of the two types of clams would be very similar. Even so, respondents were asked the same questions about arrival condition for each type of clam. The numbers of respondents that said they were able to detect an odor for the Ponderous Ark samples were identical to those for Blood Ark clams (Table 16).

Table 16. Detection of Odor in Ponderous Ark Clams.

Ponderous Ark Clam Odor	Number ----- n -----	Percent -----%-----
Able to detect an odor	21	40.4
Unable to detect an odor	31	59.6
Total	52	100.0

Approximately 60 percent of the respondents were unable to detect an odor; those that said they could detect an odor were then asked to describe it using a five-point semantic differential scale ranging from “very unpleasant” to “very pleasant. Only one respondent described the perceived odor of the Ponderous Ark clams to be “slightly unpleasant” as compared with four for the Blood Arks. Of the remaining 20 respondents, 12 described the odor as evoking a “neutral” reaction, five described it as “slightly pleasant”, and three said it was “very pleasant” (Figure 7).

Figure 7. Description of Odor for Ponderous Ark Clams.



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In addition to asking about the perception of odor, respondents were also asked to evaluate the “overall” arrival condition of the Ponderous Ark clams on a zero to ten rating scale where zero represented “extremely poor” and ten represented “extremely good”. Again, the overall arrival condition rating was virtually the same as for the Blood Ark clam samples, with a mean rating of 9.4 (Table 17). The few less-than-perfect evaluations were more than likely due to the samples arriving at a slightly higher than ideal temperature.

Table 17. Evaluations of Arrival Condition, Shell Appearance and Meat Color for Ponderous Ark Clams.

Attribute	Number	Percent	Mean Rating	Standard Deviation
	--- n ---	--- %---		
Arrival Condition <sup>a</sup>	50	96.1	9.4	1.1
Shell Appearance <sup>b</sup>	51	98.1	5.1	2.7
Meat Color <sup>b</sup>	50	96.1	3.6	3.0

<sup>a</sup> Rating Scale of 0 to 10 was defined for arrival condition as 0 = extremely poor, 10 = extremely good.

<sup>b</sup> Rating Scale of 0 to 10 was defined for shell appearance and meat color as 0 = very unattractive, 10 = very attractive.

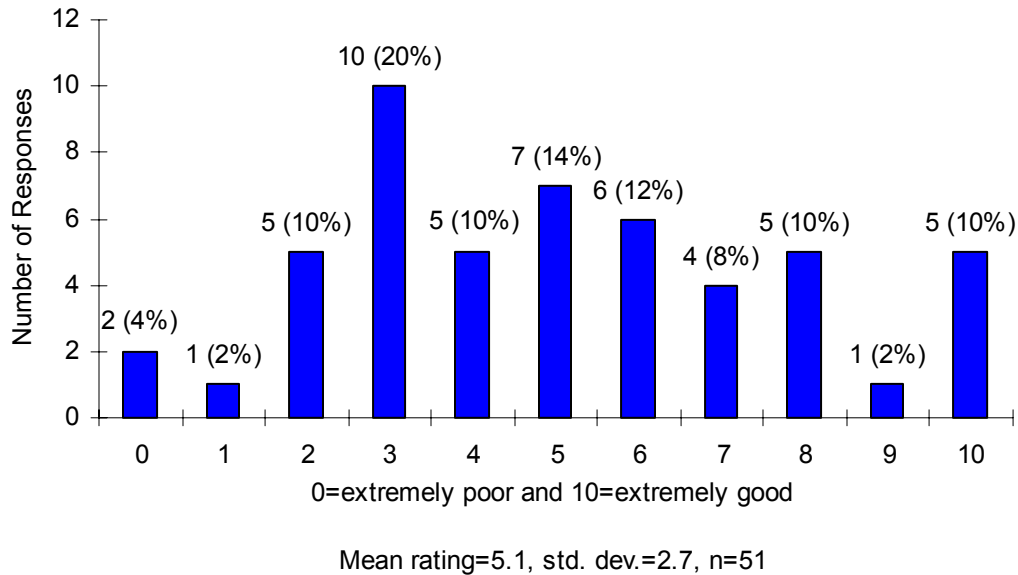
### Evaluation of Ponderous Ark Clams’ Shell Appearance

The shell of the Ponderous Ark clam is covered with a thick, feltlike periostracum that is dark brown to black in coloration. Exterior shell appearance was evaluated using a zero to ten rating scale where zero represented “very unattractive” and ten represented “very attractive”. The mean rating was 5.1, with a standard deviation of 2.7 (Table 17). Closer examination of the distribution of the ratings revealed that approximately 10 percent of the respondents rated shell appearance a “10”, or “very attractive”. However, about one-third of all respondent rated shell appearance a three or lower on the 10 point scale (Figure 8).

Respondents made a number of negative comments about the shell appearance, but no positive ones. Negative comments included “Who wants to eat a clam with fur?” “Hairiness and black color is unattractive and unappetizing—a problem”, and “Shell is hard to clean, a poor choice for whole clam garnish”. One shellfish dealer said, “The outside looks dirty...makes me think of bacterial environment and costly scrubbing”. Most of the comments mentioned the “fuzz” and black color (Appendix C, Table 2).



Figure 8. Ponderous Ark Clam Shell Appearance Ratings.



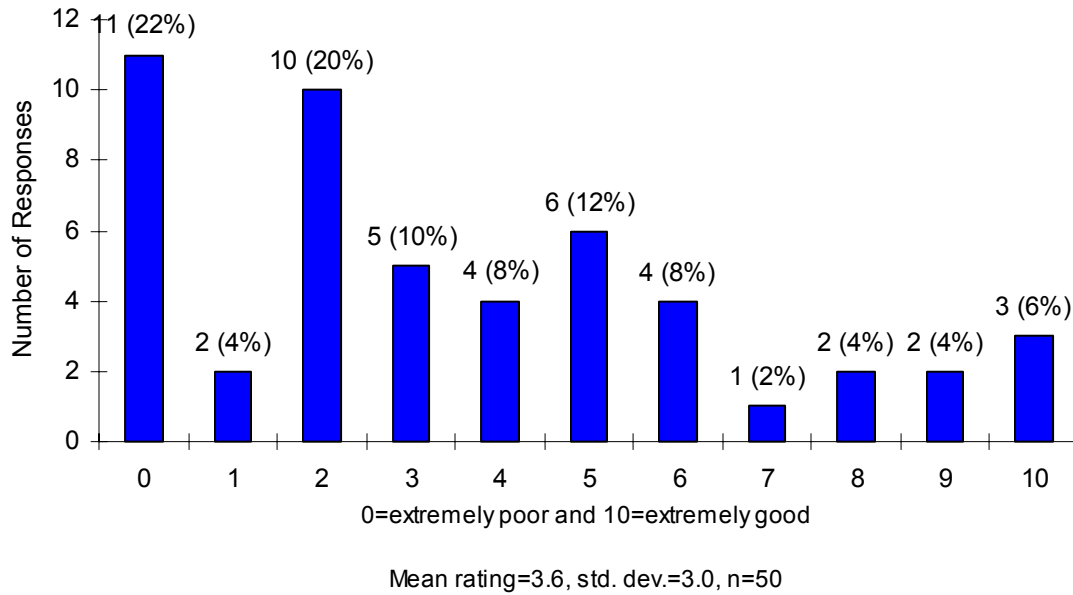
Evaluation of Ponderous Ark Clam Meat Color

Meat color was evaluated with a zero to ten rating scale as well. Zero represented “very unattractive”, and ten “very attractive”. The mean rating was 3.6, with a standard deviation of 3.0 (Table 17). As one would expect from the relatively low mean value, the distribution of the ratings is skewed towards the “unattractive” end of the scale, with 22 percent of the respondents evaluating the meat color as a zero, or “very unattractive” (Figure 9).

Respondents were also asked to comment on the meat color. Virtually all comments were negative (Appendix C, Table 2). For example, one respondent stated that the meat was “Bad, bad, gross, bio-fouled!” Others said, “Very dark juice looks bloody—very unappetizing”, and “Clams in this area are spawning when red. People will not buy.” Another shellfish dealer summed up his opinion with “[The meat color is] too dark for most clam consumers. Consumers want light colored meat. Even yellow turns them away. They connect dark with a negative...something wrong!” Yet another said “I perceived [that I had to] wash my hands thoroughly with soap after shucking and cooking these ‘clams’. Normally I do, but only as required. Yucky stuff.”

## Shellfish Industry Survey

Figure 9. Ponderous Ark Clam Meat Color Ratings.



### Ponderous Ark Clam Serving Methods and Taste Evaluations

As with the Blood Ark clams, respondents were allowed the flexibility of serving the Ponderous Ark clam samples raw, cooked, or both. Of the 52 respondents, 27 sampled them raw, and 44 cooked them in some manner (Table 18). Twenty-three respondents sampled them both ways, raw and cooked.

Table 18. Taste Ratings by Serving Method for Ponderous Ark Clams.

Serving Method	Number	Mean Rating <sup>a</sup>	Standard Deviation
Raw	27	4.8	2.6
Cooked	44	5.1	3.0

<sup>a</sup> Rating Scale of 0 to 10 was defined as 0 = very poor, 10 = extremely good.

Taste was evaluated using a zero to ten scale where zero represented “very poor”, and ten represented “extremely good”. The mean taste rating for the raw clams was 4.8, with a standard deviation of 2.6, and the mean taste rating for cooked clams was 5.1, with a standard deviation of 3.0. A paired-t test (testing the differences between cooked and raw ratings) revealed that the mean difference in taste ratings was 0.22 with a t-value of 0.45, which was not statistically significant at the 0.05 probability level.

Respondents were asked to identify each cooking method used and rate taste for each method using the same zero to ten rating scale. Thirty-two of the 44 respondents that cooked the Ponderous Ark clams did so (Table 19, Figure 10).



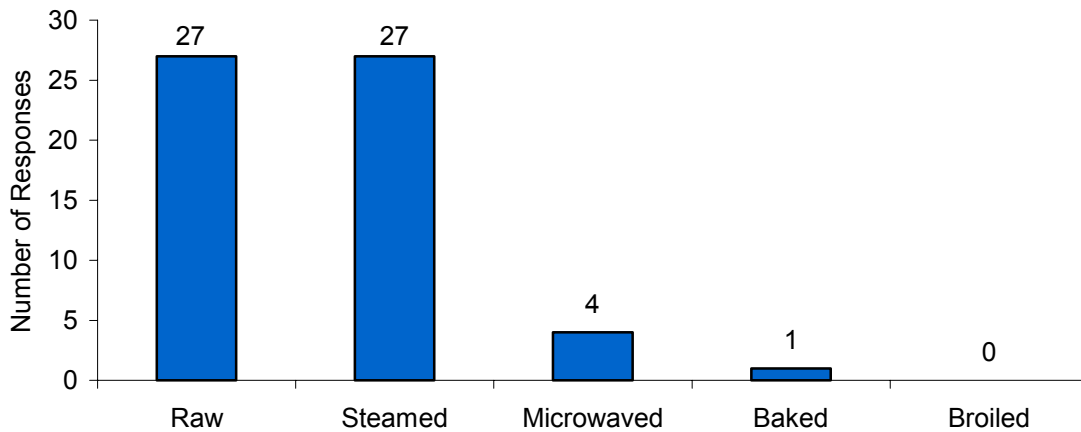
Table 19. Cooking Methods and Taste Evaluations for Ponderous Ark Clams.

Cooking Method <sup>a</sup>	Number	Percent	Mean Rating <sup>b</sup>	Standard Deviation
	-----n-----	-----%-----		
Steamed	27	84.8	4.3	2.9
Microwaved	4	12.5	5.7	1.3
Baked	1	3.1	7.0	0.0
Total	32	100.0	5.1	3.0

<sup>a</sup> Twelve respondents reported cooking Ponderous Ark Clams but failed to specify a cooking method.

<sup>b</sup> Rating Scale of 0 to 10 was defined as 0 = very poor, 10 = extremely good. <sup>c</sup> Numbers do not sum to 100 due to rounding.

Figure 10. Ponderous Ark Clam Serving Methods Used by Respondents.



Steaming was by far the most commonly used cooking method, reported by nearly 85 percent of those cooking the clam samples. The mean taste rating for steamed Ponderous Ark clams was 4.3. Four respondents (about 12 percent) microwaved them, and their mean taste rating was 5.7 on the 0 to 10 scale. One respondent baked the samples, and rated taste as a “7”. There were too few observations to statistically test for differences among the cooking methods (Table 19).

Comments about taste were mixed, with about as many positive comments as negative. On the positive side, respondents said the Ponderous Ark samples were “good for sushi”, “a good chowder clam”, “the flavor was good”, and “nice briny clam flavor”. Examples of negative comments included “they double suck raw”, “rather bitter”, “taste too strong”, and “did not like the taste; they were bitter and had an aftertaste” (Appendix C, Table 2).

Texture Ratings for Ponderous Ark Clams

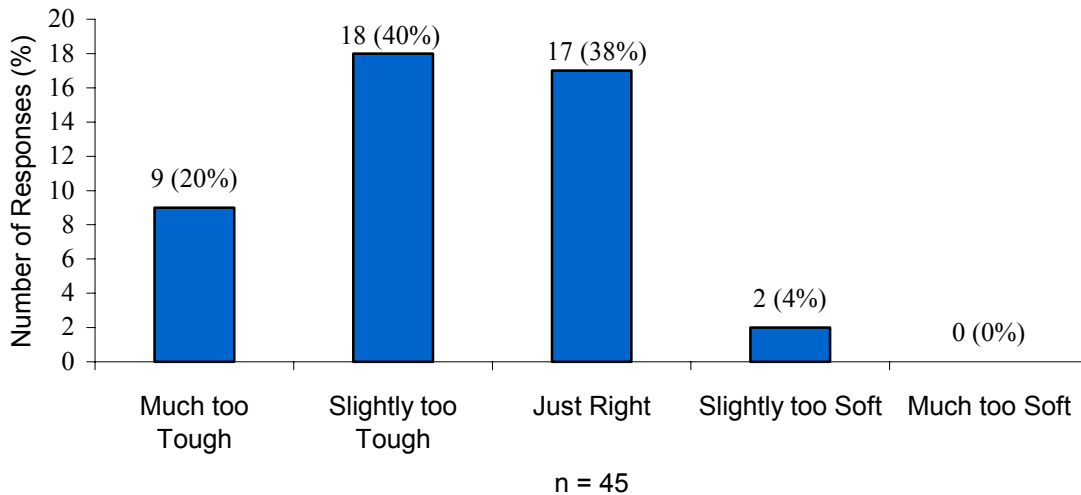
Respondents were asked to rate the texture of the Ponderous Ark clams using the same five-point semantic differential scale used for Blood Arks. The five points were defined as “much too tough”, “slightly too tough”, “just right”, “slightly too soft”, and

## Shellfish Industry Survey

“much too soft”. Of the 49 respondents that rated texture, one-fifth said they were “much too tough”, and about 40 percent said they were “slightly too tough” (Figure 11). Approximately one-third said the texture was “just right”. Only two respondents said they were “slightly too soft”, and no one said they were “much too soft.”

Respondents were not asked to comment specifically on their reaction to texture, but several volunteered statements. One indicated that they texture would be acceptable to their niche market, i.e., Asians, but several comments were negative. For example, one stated, “Texture could be better”, and another said “Very chewy [rated them “much too tough”]”. A final comment was related to cooking time required: “When I cooked these clams they did not open, which lead to over-cooking and therefore [they were] way too tough” (Appendix C, Table 2).

Figure 11. Ponderous Ark Clam Texture Ratings.



### Size Preferences for Ponderous Ark Clams

The Ponderous Ark clam samples were of relatively uniform size within the two size categories shipped. The “medium” sized clams averaged 1 7/8” in shell length, 1 1/5” in shell width and 17 per pound. The “large” sized clams averaged 2” in shell length, 1 1/3” in shell width and 11 per pound. Respondents were asked to rate size using a five point semantic differential scale which included “much too small”, “slightly too small”, “just right”, “slightly too large”, and “much too large”. Nearly two-thirds of the respondents said they were “just right”, but about one-third thought they were “somewhat too small”; 7 percent said they were “much too small”, and 27 percent felt they were “slightly too small”. One could conclude that the medium to large-sized clams (12 to 24 per pound) would be widely accepted as ideal.

Although comments on size were not directly solicited, a few respondents made statements with regard to size when asked for general reactions, and virtually all were critical of the smaller clams. One respondent stated, “These animals need to be



developed—current market thinks larger is better”. A Maine dealer compared the Ponderous Ark clams to his state’s requirements that clams be two inches in diameter, with a +/- size tolerance, implying that the Ponderous Ark clams were too small. Other comments included “Smaller-sized clams failed to open when steamed”, “Meats were small”, and “Some clams were too small”. One respondent suggested that they be grown to three inches in order to develop a product for processing (Appendix C, Table 2).

Estimated Weekly Sales Of Ponderous Ark Clams

Respondents were asked how many Ponderous Ark clams their firms could sell each week, if any, assuming that they were available on a year-round basis at prices “comparable to hard clams from Florida”. Of the 44 respondents that answered this question, nearly 60 percent said “none”. Twenty-two percent indicated that they could probably sell some, but would not provide an estimate, and eight firms provided estimates (Table 20).

Table 20. Estimated Weekly Sales Of Ponderous Ark Clams.

Estimated Weekly Sales	Number	Percent
	-----n-----	-----%------
Number reporting a positive value	8	18.2
Don’t know	10	22.7
None	26	59.1
Total	44	100.0

As was the case with Blood Ark clams, sales estimates provided by the eight firms were extremely variable, ranging from only 30 to 120,000 clams per week. The mean estimated clam sales figure for the eight firms was about 18,600 clams per week per firm, but given the extreme variability of the estimates, the mean is of little value. Out of the total estimated weekly Ponderous Ark clam sales of approximately 149,000 animals, one West coast firm’s estimate accounted for 120,000. Four of the eight firms estimated that their Ponderous Ark clam sales would be 1,000 or fewer; three additional firms’ estimates ranged from 5,000 to 12,000 per week, and only one respondent thought he could sell more than 12,000 per week, and this West coast firm estimated potential sales at 120,000 clams per week. Estimated sales were analyzed on a regional basis, and found to be extremely variable as well. Sales estimates in the Northeast ranged from 1,000 to 12,000 clams per week; in the South, estimates ranged from 300 to 10,000 per week, and in the West from 30 to 120,000 clams (Table 21).

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Table 21. Ranges of Estimated Weekly Sales of Ponderous Ark Clams, by U. S. Region.

Region	Number of Firms -----n-----	Number of Clams Sold -----n-----
Northeast	3	1,000 – 12,000
South	2	300 – 10,000
Midwest	0	--
West	3	30 – 120,000
Total	8	30 – 120,000

General Observations on Ponderous Ark Clams
*Cooking Problems*

After rating specific physical attributes of the Ponderous Ark clams, respondents were asked for their general reactions to the samples. Many mentioned difficulties associated with cooking and opening the clams. For example, one said, “they were extremely difficult to open...our clams open much more readily. We found the clams difficult to cook as the cooking times varied greatly. One opened up after six minutes, four did not open after 10 minutes, and three opened after 35 minutes”. Others observed “very hard to open, even when cooked a long time”, “failed to open when steamed”, and “They did not steam open after 10 minutes of hard steaming—actually had to pry open. Way too much cooking time and work!”

*Marketability*

Despite a preponderance of negative observations for shell appearance, meat color and taste and marketability, there were a few positive comments that related to market potential for Ponderous Ark clams. For example, one said, “[I] have customers with interest”. Another observed, “It would take prior marketing tools and efforts to sell them. After 30 years selling full-line seafood, this seems like an Asian item”. Others said, “[I] have no established market for the clam, [but there is] some use among Asian communities” and “Could be a product that could be developed for Asian markets. Another volunteered, “They [Ponderous Ark clams] are known as an expensive side dish in Korea...could be a regular [sic] sold item for Korean and Japanese markets and restaurants, and even exported to Korea”.



**Comparisons of Selected Attributes of Blood Ark and Ponderous Ark Clams**

A paired t-test was used to compare respondents’ ratings of arrival condition, meat color, and taste ratings (cooked and raw) for the two types of ark clams to determine the presence of any statistically significant differences in ratings. These variables were measured using a numeric rating scale. The paired t-test utilizes each respondent’s ratings for each type of clam for each attribute; in order to have a valid observation, the respondent must have rated each type of clam for the attribute so that a rating difference can be calculated. The t-test is then based upon the mean difference over all respondents and the variance associated with the individual rating differences.

Comparisons between Blood Ark and Ponderous Ark clams (Blood Ark ratings minus Ponderous Ark ratings) revealed little difference between the two types of clams. As expected, arrival condition ratings were not statistically different at the 0.05 probability level (Table 22).

Meat color comparisons represented the only statistically significant difference among other product attributes evaluated using the numeric rating scales. Respondents showed a preference for the meat color of the Blood Ark clam over the Ponderous Ark, but shell appearance and taste ratings (when eaten raw or cooked) were similar for both species of clams (Table 22).

Two other product attributes, odor and texture, had been evaluated by respondents via a semantic differential rating scale. Chi-square tests could not be used to analyze these ratings to find if there were statistically significant differences between the two types of clams because there were too few observations for valid tests. Visual examination of the distribution of ratings for both odor and texture revealed little difference between Blood Ark and Ponderous Ark clams.

Table 22. Paired t-values for Selected Variables - Blood and Ponderous Ark Clams.

Attribute	No. of Comparisons	t-value <sup>a</sup>
Arrival Condition	50	0.18
Appearance of shells	51	0.71
Color of the meat	47	2.06*
Taste Rating, eaten raw	26	0.95
Test Rating, eaten cooked	40	0.90

<sup>a</sup>Paired t-values are based upon the differences in individual respondents ratings of attributes of Blood Ark and Ponderous Ark Clams, i.e. the ratings for Blood Arks minus the ratings for Ponderous Arks. An asterisk indicates statistical significance at the 0.05 percent probability level.

## **CONCLUSIONS**

The survey of all certified shellfish wholesalers (dealers) in the U.S. revealed very limited distribution and sales of both the Blood Ark and Ponderous Ark clams. About 92 percent of the responding shellfish firms had no experience with Blood Ark clams, and nearly 97 percent have had no experience with Ponderous Ark clams. Further, only one percent of respondent firms reported sales of either type during 2001, thus it is apparent that market exposure in the U.S. is extremely limited. The initial trade survey showed very limited knowledge about these clams among dealers. The few that were either currently selling them or had sold them in the past cited several factors that had negatively influenced their sales. These factors included lack of consistent supplies, limited market outlets and virtually nonexistent consumer demand.

One can also conclude that there is relatively little interest in these ark clams among certified shellfish wholesalers nationwide. Out of the 1,848 initial questionnaires which requested information on the clams and offered free samples for evaluation, only 309 usable responses were obtained; of these, only 97 indicated a preliminary willingness to try them, and when the samples were available, only 83 firms agreed to accept them. After these firms received their samples, only 52 responded with product evaluations despite numerous follow-up reminder calls. Of the 52 firms evaluating the samples, only 20 gave an indication that they might be able to sell Blood Arks, and 18 indicated the possibility of selling Ponderous Arks. These 18 to 20 firms represent about one percent of all certified shellfish wholesalers in the U.S.

As to the potential marketability of these species, the product evaluations and many of the respondents' comments indicated that these two species of ark clams are perceived as being too different from clams currently available on the market. These findings, coupled with shellfish dealers' unwillingness to evaluate free samples, leads us to conclude that it is unlikely that there will be widespread, mainstream demand for them.

Despite the overall negative tone of these findings, market development proponents should recognize the importance of ethnic markets in target locations on the East coast and West coasts. Targeting seafood dealers in these areas with large Asian and Hispanic populations could result in profitable niche markets.

Additionally, producer groups should work with the Division of Marketing within the Florida Department of Agriculture and Consumer Services (FDACS) to provide information about Blood Ark and Ponderous Ark clams to potential dealers at national seafood trade shows. Such information could also be incorporated into the FDACS website to foster greater knowledge in the trade and to arouse dealers' curiosity. These promotional methods could serve as relatively inexpensive promotional tools.



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**APPENDIX A**

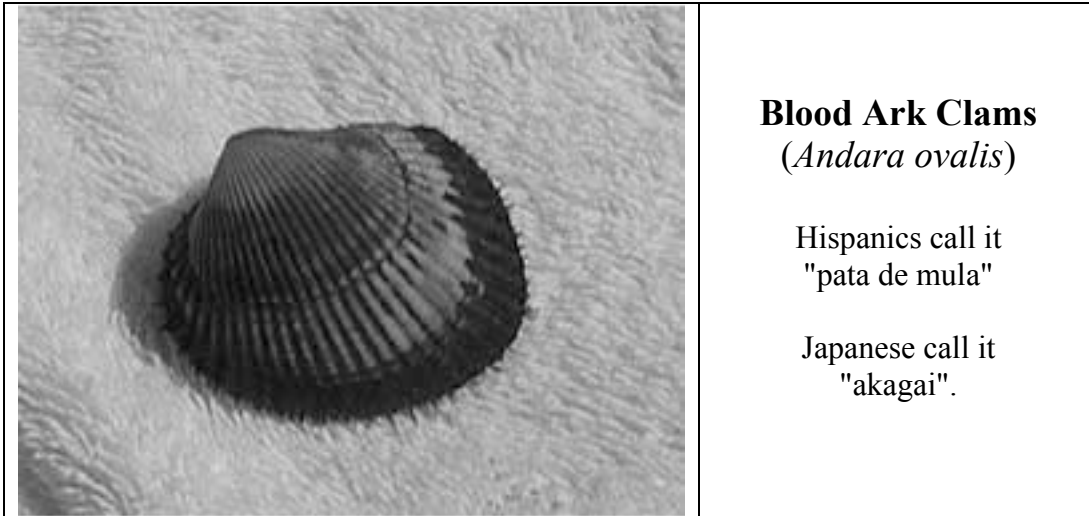


**Phase I, Shellfish Industry Questionnaires**



**Shellfish Industry Survey**

Please complete this hard copy and return it in the enclosed business reply envelope.



Q1. Which of the following describe your experience with **Blood Ark clams**?  
*(Check only one)*

- A.  Have no experience with **Blood Ark clams** whatsoever. *(Skip to Q13)*
- B.  Have seen **Blood Ark clams** at industry trade shows. *(Skip to Q13)*
- C.  Have sold **Blood Ark clams** in the past but not currently selling them.  
 If not currently selling them, why not? *(Answer, then skip to Q6)*

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- D.  Currently selling fresh **Blood Ark clams**.

Q2. If you are currently handling fresh **Blood Ark clams** what states or countries are your major suppliers? *(List in order of importance)*

- A. \_\_\_\_\_
- B. \_\_\_\_\_
- C. \_\_\_\_\_
- D. \_\_\_\_\_

Q3. To what four states do you ship the greatest volume of fresh Blood Ark clams? What percentage of your fresh **Blood Ark clams** goes to each of these states?



<b>Top 4 States for Fresh Blood Ark Clam Volume</b>	<b>Percent</b>
	%
	%
	%
	%

Q4. Approximately how many fresh **Blood Ark clams** did you sell in all of 2001?  
*(Give estimate in number of clams)* \_\_\_\_\_

What percentage of these were sold in the Winter (Jan. – March)? \_\_\_\_\_ %

What percentage of these were sold in the Spring (April - June)? \_\_\_\_\_ %

What percentage of these were sold in the Summer (July – Sept.)? \_\_\_\_\_ %

What percentage of these were sold in the Fall (Oct. – Dec.)? \_\_\_\_\_ %

TOTAL

100 %

Q5. In 2001, what were the lowest, highest, and average prices you paid for fresh **Blood Ark clams**? *(Give prices on a per clam basis)*

**Lowest price** \_\_\_\_\_ **cents each**

Highest price \_\_\_\_\_ cents each

Average price \_\_\_\_\_ cents each

Q6. How would you rate the overall quality of fresh **Blood Ark clams** that you received during the past year? *(Use a rating scale where 10=excellent and 0=very poor. You may select any number from 0 to 10).*

**OVERALL QUALITY RATING:** \_\_\_\_\_

Q7. What, if anything, could **Blood Ark clam** producers do to increase retail sales?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Q8. What types of outlets buy fresh **Blood Ark clams** from your firm?  
*(Check all that apply)*

**Shellfish Industry Survey**

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- |  |  |
|--|--|
| <input type="checkbox"/> Other wholesalers (re-shippers) | <input type="checkbox"/> Large retail grocers    |
| <input type="checkbox"/> Specialty seafood retailers     | <input type="checkbox"/> Independent restaurants |
| <input type="checkbox"/> Small retail grocers            | <input type="checkbox"/> Chain restaurants       |

Q9. In your opinion, what **ethnic groups** represent the most important markets for fresh **Blood Ark clams**? (*List in order of importance, where 1=most important and 4=least important*)

- 1<sup>st</sup> \_\_\_\_\_
- 2<sup>nd</sup> \_\_\_\_\_
- 3<sup>rd</sup> \_\_\_\_\_
- 4<sup>th</sup> \_\_\_\_\_

Q10. On average what is the shelf life of fresh **Blood Ark clams**?

**Days from Harvest:** \_\_\_\_\_

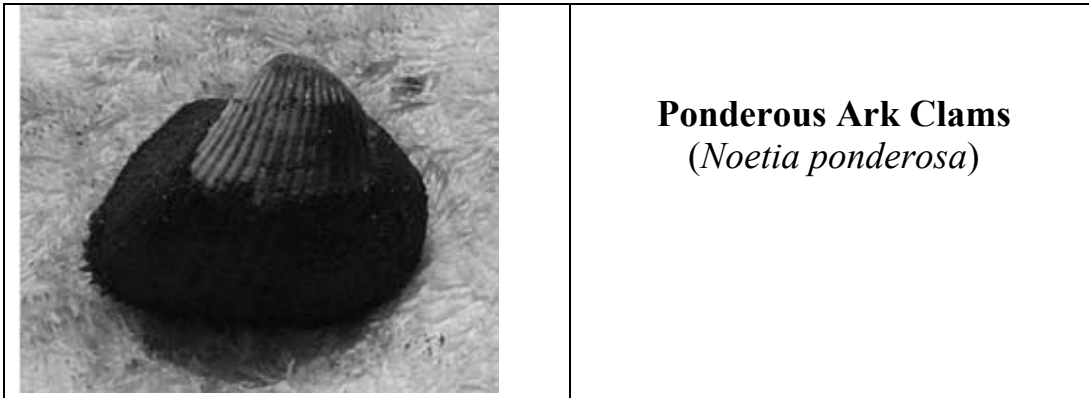
Q11. Which of the following shell sizes of **Blood Ark clams** are most popular in your market? (*Rank 1st, 2nd, and 3rd*)

- \_\_\_\_\_ Small – Average  $\frac{3}{4}$  inch wide,  $1\frac{1}{4}$  inches long, 34 clams/pound
- \_\_\_\_\_ Medium – Average 1 inch wide,  $1\frac{1}{2}$  inches long, 20 clams/pound
- \_\_\_\_\_ Large – Average  $1\frac{1}{4}$  inches wide,  $1\frac{3}{4}$  inches long, 13 clams/pound

Q12. Which of the following meat colors of **Blood Ark clams** do you prefer?  
(*Check only one*)

- Lighter color
- Medium color
- Darker color
- No preference





Q13. Which of the following describe your experience with **Ponderous Ark clams**?  
*(Check only one)*

- A.  Have no experience with **Ponderous Ark clams** whatsoever. *(Skip to Q25)*
- B.  Have seen **Ponderous Ark clams** at industry trade shows. *(Skip to Q25)*
- C.  Have sold **Ponderous Ark clams** in the past but not currently selling them.  
If not currently selling them, why not? *(Answer, then skip to Q18)*

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D.  Currently selling **Ponderous Ark clams**.

Q14. If you are currently handling fresh **Ponderous Ark clams** what states or countries are your major suppliers? *(List in order of importance)*

- A. \_\_\_\_\_
- B. \_\_\_\_\_
- C. \_\_\_\_\_
- D. \_\_\_\_\_

Q15. To what four states do you ship the greatest volume of fresh **Ponderous Ark clams**?  
What percentage of your fresh **Ponderous Ark clams** goes to each of these states?

Top 4 States for Fresh Ponderous Ark Clam Volume	Percent
	%
	%
	%
	%



Q16. Approximately, how many fresh **Ponderous Ark clams** did you sell in all of 2001? *(Give estimate in number of clams)* \_\_\_\_\_

What percentage of these were sold in the Winter (Jan. – March)? \_\_\_\_\_ %

What percentage of these was sold in the Spring (April - June)? \_\_\_\_\_ %

What percentage of these was sold in the Summer (July – Sept.)? \_\_\_\_\_ %

What percentage of these was sold in the Fall (Oct. – Dec.)? \_\_\_\_\_ %

TOTAL 100 %

Q17. In 2001, what were the lowest, highest, and average prices you paid for fresh **Ponderous Ark clams**? *(Give prices on a per clam basis)*

**Lowest price** \_\_\_\_\_ **cents each**

**Highest price** \_\_\_\_\_ **cents each**

**Average price** \_\_\_\_\_ **cents each**

Q18. How would you rate the overall quality of fresh **Ponderous Ark clams** that you received during the past year? *(Use a rating scale where 10=excellent and 0=very poor. You may select any number from 0 to 10).*

**OVERALL QUALITY RATING:** \_\_\_\_\_

Q19. What, if anything, could **Ponderous Ark clam** producers do to increase retail sales?

◆ \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Q20. What types of outlets buy fresh **Ponderous Ark clams** from your firm? *(Check all that apply)*

- |                                       |                               |
|---------------------------------------|-------------------------------|
| _____ Other wholesalers (re-shippers) | _____ Large retail grocers    |
| _____ Specialty seafood retailers     | _____ Independent restaurants |
| _____ Small retail grocers            | _____ Chain restaurants       |

Q21. In your opinion, what **ethnic groups** represent the most important markets for fresh **Ponderous Ark clams**? *(List in order of importance, where 1=most important and 4=least important)*

1<sup>st</sup> \_\_\_\_\_

**Shellfish Industry Survey**

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2<sup>nd</sup> \_\_\_\_\_  
3<sup>rd</sup> \_\_\_\_\_  
4<sup>th</sup> \_\_\_\_\_

Q22. On average what is the shelf life of fresh **Ponderous Ark clams**?

Days from Harvest: \_\_\_\_\_

Q23. Which of the following shell sizes of **Ponderous Ark clams** are most popular in your market? (*Rank 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup>*)

\_\_\_\_\_ Small – Average  $\frac{3}{4}$  inch wide,  $1\frac{1}{4}$  inches long, 32 clams/pound  
\_\_\_\_\_ Medium – Average 1 inch wide,  $1\frac{1}{2}$  inches long, 24 clams/pound  
\_\_\_\_\_ Large – Average  $1\frac{1}{4}$  inches wide,  $1\frac{3}{4}$  inches long, 12 clams/pound  
\_\_\_\_\_ Extra Large – Average  $1\frac{1}{2}$  inches wide,  $2\frac{1}{4}$  inches long, 7 clams/pound

Q24. Which of the following meat colors of **Ponderous Ark clams** do you prefer?  
(*Check only one*)

\_\_\_\_\_ Lighter color  
\_\_\_\_\_ Medium color  
\_\_\_\_\_ Darker color  
\_\_\_\_\_ No preference

Q25. Which of the following categories best describes your total shellfish sales for 2001?  
(*Check appropriate answer*)

_____ Less than \$100,000	_____ \$1,000,000 to \$4,999,999
_____ \$100,000 to \$499,999	_____ \$5,000,000 to \$9,999,999
_____ \$500,000 to \$999,999	_____ \$10,000,000 or more



Q26. Which of the following aquacultured clams, if any, would you be willing to evaluate next year (Fall of 2003)? (*Check appropriate boxes (es) and provide name, address, etc. below*)

I want to evaluate a sample of **Blood Ark Clams**             Yes             No

I want to evaluate a sample of **Ponderous Ark Clams**     Yes             No

NAME \_\_\_\_\_ TITLE \_\_\_\_\_

STREET \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

TELEPHONE (\_\_\_\_\_) \_\_\_\_\_ EMAIL \_\_\_\_\_

**APPENDIX B**



**Phase II, Shellfish Industry Questionnaires**



**Shellfish Industry Survey**
*Blood Ark Clam Questionnaire (Anadara ovalis)*  
**(Orange Mesh Bag)**
Arrival Condition

- (1) Please smell the Blood Ark clams.  
 Are you able to detect an odor or not? [Check one]  
 \_\_\_\_\_ **No** \_\_\_\_\_ **Yes**

If yes, how would you describe the odor? [Check one]

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Very</b>	<b>Slightly</b>	<b>Neutral</b>	<b>Slightly</b>	<b>Very</b>
<b>Unpleasant</b>	<b>Unpleasant</b>		<b>Pleasant</b>	<b>Pleasant</b>

- (2) Please circle the number that reflects **overall arrival condition**:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Extremely Poor** **Extremely Good**

Comments: \_\_\_\_\_

- (3) Please rate the **appearance of the shells** [Circle one number]:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Very Unattractive** **Very Attractive**

- (4) Please rate the **color of the meat** (entire animal) [Circle one number]:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Very Unattractive** **Very Attractive**

Comments: \_\_\_\_\_

- (5) Please rate the **taste** for the serving method(s) you used [Circle one number]:

If eaten **raw**:

<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>Very</b>										<b>Extremely</b>
<b>Poor</b>										<b>Good</b>

If **cooked**, circle the cooking method (steamed, microwaved, baked, or broiled), then rate taste [Circle one number]:

<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>Very</b>										<b>Extremely</b>
<b>Poor</b>										<b>Good</b>

- (6) Please rate the **texture** of the Blood Ark clams [Circle one number]:

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Much</b>	<b>Slightly</b>	<b>Just</b>	<b>Slightly</b>	<b>Much</b>
<b>Too Tough</b>	<b>Too Tough</b>	<b>Right</b>	<b>Too Soft</b>	<b>Too Soft</b>

- (7) There are two size grades of Blood Ark clams in the orange mesh bag, "medium" and "large". Which size do you feel would be most popular in your market area? [Check one]  
 \_\_\_\_\_ **Medium** \_\_\_\_\_ **Large** \_\_\_\_\_ **Both equally popular** \_\_\_\_\_ **Do not know**



- (8) If Blood Ark clams were available year round at prices comparable to hard clams from Florida, how many, if any, do you feel you could sell each week? [Enter number per week]

\_\_\_\_\_ **Blood Ark clams per week**

- (9) Please give us your general reaction to these Blood Ark clams (use back if necessary):

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**Shellfish Industry Survey**
*Ponderous Ark Clam Questionnaire (Noetia ponderosa)*  
 (Black Mesh Bag)

Arrival Condition

- (1) Please smell the Ponderous Ark clams.  
 Are you able to detect an odor or not? [Check one]  
 \_\_\_\_\_ No \_\_\_\_\_ Yes

If yes, how would you describe the odor? [Check one]

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Very Unpleasant</b>	<b>Slightly Unpleasant</b>	<b>Neutral</b>	<b>Slightly Pleasant</b>	<b>Very Pleasant</b>

- (2) Please circle the number that reflects **overall arrival condition**:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Extremely Poor** **Extremely Good**  
 Comments: \_\_\_\_\_

- (3) Please rate the **appearance of the shells** [Circle one number]:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Very Unattractive** **Very Attractive**

- (4) Please rate the **color of the meat** (entire animal) [Circle one number]:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Very Unattractive** **Very Attractive**  
 Comments: \_\_\_\_\_

- (5) Please rate the **taste** for the serving method(s) you used [Circle one number]:
- If eaten **raw**:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Very Poor** **Extremely Good**

- If **cooked**, circle the cooking method (steamed, microwaved, baked, or broiled), then rate taste [Circle one number]:  
**0 1 2 3 4 5 6 7 8 9 10**  
**Very Poor** **Extremely Good**

- (6) Please rate the **texture** of the Ponderous Ark clams [Circle one number]:
- |                       |                           |                   |                          |                      |
|-----------------------|---------------------------|-------------------|--------------------------|----------------------|
| <b>1</b>              | <b>2</b>                  | <b>3</b>          | <b>4</b>                 | <b>5</b>             |
| <b>Much Too Tough</b> | <b>Slightly Too Tough</b> | <b>Just Right</b> | <b>Slightly Too Soft</b> | <b>Much Too Soft</b> |

- (7) Please rate the size of the Ponderous Ark clams:
- |                       |                           |                   |                           |                       |
|-----------------------|---------------------------|-------------------|---------------------------|-----------------------|
| <b>1</b>              | <b>2</b>                  | <b>3</b>          | <b>4</b>                  | <b>5</b>              |
| <b>Much Too Small</b> | <b>Slightly Too Small</b> | <b>Just Right</b> | <b>Slightly Too Large</b> | <b>Much Too Large</b> |



(8) If Ponderous Ark clams were available year round at prices comparable to hard clams from Florida, how many, if any, do you feel you could sell each week? [Enter number per week]  
\_\_\_\_\_ **Ponderous Ark clams per week**

(9) Please give us your general reaction to these Ponderous Ark clams (use back if necessary):

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**APPENDIX C**



**Phase II, Shellfish Industry Comments**



Appendix C, Table 1. Respondents' Comments About Blood Ark Clams, Phase II Findings.

Obs. No.	Condition	Appearance	Color	General Reactions
1		Clam was interesting in looks.		Taste was bitter.
2				Good for sushi.
3				Very good in the future market. Let me know when the clams are available.
4		Should have cleaner shell to steam.		Hard to open with a knife. The clams were rubbery but OK taste.
5				
6			Sent out whole.	They like the ponderous ark better.
7				The appearance is the major factor for selling this product. Comparable to others, seems Asian market is your best bet.
8			Red in color.	This type of clam would only be on interest to certain ethnic groups. However, if you went after these specific markets, this clam could be successful.
9			The color of the meat is a turnoff.	Good flavor and texture.
10				Would have a hard time competing against our black soft shell mud clams, sweet and tender, state of ME has 2" shell size on clams with 10% tolerance.
11			Raw ugly/cooked normal/not as furry.	They suck raw.
12			Bad, bad gross.	Salty but tough when raw, steamed: took way too long, safety issue. Brown steam water would not cut! Health issue. Shell nicer shape than other sample. How clean shell before steaming? Water after steaming "gross": brown with stuff in it? Overall attitude from samplers, "GROSS".
13				



Obs. No.	Condition	Appearance	Color	General Reactions
14			As far as these animals go, meat is acceptable.	Clams need to be larger.
15				As far as I know no one eats them. We throw them away for junk.
16				Not bad. Comparable to Northern wahoganays, which I do not sell.
17	Ice pack was all melted.			Cooked ones are imported from Korea, which does not give much flavor. Will be a good selling item if prices are right.
18		Dirt on clams and redness of clams.		People in this area will not buy them because of the dirt on clams and the redness in clam.
19				Very good flavor, ugly meat.
20				
21				Could be a product a market could be developed for.
22				Fresh, good overall appearance, different taste.
23	All alive and cold.		Bulk fuzz needs to be removed, blood appearance borders on unappealing.	Fuzz and blood a problem.
24			Looks like raw liver.	In comparison to many fine clams available on the West Coast which are attractive, easy to cook, and very tasty with a sweeter flavor, we do not feel these clams would be marketable in our marketing area. Due to the very heavy shells, the shelf life would probably be good, however, at the same time shipping costs would be more expensive. We are sorry that our answers are brutally frank and wish we could be more positive.
25				They wouldn't open – could not eat.
26				My feelings are the same for both clams except this clam was easy to cook and get out of shell.

## Shellfish Industry Survey



Obs. No.	Condition	Appearance	Color	General Reactions
27		Hard to clean organic material off shell.		This clam was hard to clean which would make them a poor choice for use as a whole garnish, i.e.: white clam sauce or marinara.
28		Very unattractive.		Very unattractive – open rapidly when steamed – meat tasted all right but the color, texture and overall appearance was very poor. The color was much too dark.
29				Not able to sell to my customers.
30				Rather bitter in taste, volume of meat relating to shell size poor. In my opinion, these would be more valuable for their shells.
31	Shell stock temp average 50 degrees.		Dark color – blood juice.	Not appetizing.
32				Not saleable in this area.
33	Temp of clams 58 degrees.			I do not like the blood. Temp of clams 58 degrees. Not enough ice in package. Product needs to be 40 degrees or below.
34				
35	Interior of box was warm – gel packs melted but clams firm.	Hairy cover not likeable.	Not as white! Dark chocolate brown stomach.	I elected to steam the blood ark clams, as I feel steaming is the way of the future. I found the clams to be tender, but still full of too much liquid to say I honestly liked their texture. I did however steam them only until they opened and then sampled. After 3 days of adequate cold storage, I found the blood ark clams “edible” but no desirable. Even after waiting for a “drying-out period” after initial steaming, I still found them “visceral”. Too many thin skinny membranes to be chewed and swallowed. Just to me though, but I love eating clams. Overall 3 out of 10. Upon steaming blood arks, already noticed they did not steam open as quickly.
36	Cool – in good shape.			If they were cheap enough, people may buy them. They would not be good for steamed half shells.
37		Shell stock looked good to me	The reddish color –	Shell stock looked good to me except for moss growth on



Obs. No.	Condition	Appearance	Color	General Reactions
		except for moss growth on shell.	not attractive.	shell. Good texture, good flavor compared to ME hard shell clam. Only drawback is red blood color when eaten raw. Didn't cook any.
38			Due to clams being almost black, they lefts a black film in the pan.	Due to clams being almost black, they lefts a black film in the pan. Not good and only one clam opened after 15 minutes of steaming.
39				The larger blood clam would be easier for us to sell, as our customers prefer the larger size. I could easily sell 3 to 5k lbs. weekly.
40	Very nice, clean appearance.		They are very colorful compared to other shellfish.	The clams were shipped 11/17 and our test was done 11/21.
41		Fuzzy dirty 'appearance'		Bad name, fuzzy dirty 'appearance' not desirable in this area compared to hard shell clam or midneck clam.
42				Could eat raw or steamed. Liked salinity vs. ponderous arks.
43		I would want to scrub before serving – looks like not super-sanitary.	Better than ponderous arks.	Some chefs preferred ponderous while others preferred blood. I found few chefs that were ready to jump on product.
44				
45				
46				Not suitable for this area where we have our own hard clams.
47				
48				Glad to see them – have customers with interest.
49				The blood ark was not as strong as the ponderous ark clam.
50				Much too strong flavor.
51				Excellent taste and presentation.
52	Clams travel well.		Lighter meat usually a positive.	Don't have a market. There is a limited Asian market in NYC for these clams. I have no exposure to those mkts.

## Shellfish Industry Survey



Appendix C, Table 2. Respondents' Comments About Ponderous Ark Clams, Phase II Findings.

Obs. No.	Condition	Appearance	Color	General Reactions
1				Had better taste than others, but needed something to spice it up, I steamed in water only.
2				Good for sushi.
3				Very good for the future market.
4				Could not open more than two clams by steaming/boiling/microwaving or with a knife.
5				
6				Looked like something for the Oriental market.
7				Again, the appearance, taste and texture of clams designate good sales for our niche market. This would be a hard sell compared to other clams.
8			Red in color.	Most American clam eaters would not find this type of clam desirable. It is very popular, however, among certain ethnic groups. If marketed specifically this type of shellfish would be very successful.
9				Flavor good (color not). Texture could be better. Good chowder clam.
10				Would have hard time competing against our black soft shell mud clams, sweet and tender, state of ME has 2" shell size on clams with 10% tolerance.
11	Kind of furry.			They double-suck raw / Good cooked / Unique.
12		Shell square-shaped (weird).	Bad, bad, gross, bio-fouled.	Shell square-shaped (weird). Growth of other creatures looked bad. When opened blood juice on shucking hand. "To sell must hide processing (cooking) from everyone. No way in traditional recipes. Terrible visual." I needed (perception) to wash hands thoroughly with soap after shucking and cooking these "clams". Normally I do, but only as required. Yucky stuff.
13				
14			Pretty gross to me!	Theses animals need to be developed. Current market



Obs. No.	Condition	Appearance	Color	General Reactions
15				thinks large is better. As far as I know no one eats them, we throw them away for junk.
16				When I cooked these clams they did not open which lead to over-cooking and therefore way too tough.
17	Ice pack was melted.			Know as an expensive side dish in Korea, but cannot be imported unless cooked, which takes away the flavor. Could be regularly sold items for Korean and Japanese market and restaurants, and even exporting to Korea.
18		Too much blood and dirt.		Too much blood, customer will not buy anything that looks like that. Too much dirt on shells. Clam in this area are spawning when red. People will not buy.
19				Bland taste.
20				
21				Could be a product that could be developed for Asian markets.
22				Nice, well-rounded product.
23	All alive and cold.	Blood appearance borders on unappealing.		Fuzz and blood a problem.
24	Well-packed but gel was melted.	Appearance - hairiness and black color – unattractive; shape – OK.	Very dark juice looks bloody – very unappetizing.	Appearance - hairiness and black color – unattractive; shape – OK. The black color of the raw meat and juice is not very appealing or appetizing. The inside of the shell is very attractive and would be wonderful for serving, however, the meat was not attractive or appetizing, the raw clam was extremely difficult to open for a Westerner, as our clams open much more readily. We found the clams difficult to cook as the cooking times varied greatly. Out of clams, 3 opened after 35 minutes, 1 after 6 minutes, 4 did not open after 10 minutes. If over-cooking toughens the clam meat, preparation of the clams would be difficult. The broth was fairly good but the color was not appetizing.
25				Visually much different than what New England is

## Shellfish Industry Survey



Obs. No.	Condition	Appearance	Color	General Reactions
				accustomed to. Very bloody – wouldn't want to eat them uncooked. Nice briny clam flavor. Very chewy.
26			It is what it is buy most people would not like color.	I have been a fisherman all my life I would eat anything that comes out of the sea, but these clams would be very hard to sell. They don't taste better than a hard clam and look worse. The price would have to start very low to encourage people to try them also the name is not very enticing. Mussel clam would market better. The meat looks somewhat like a mussel. This clams was also very hard to open even when cooked a long time and the juice was dark.
27				Again, shell hard to clean, which makes them a poor choice for whole clam garnish.
28			Too dark – very unappetizing.	The smaller-sized clams failed to open when steamed. The larger opens opened but were very unappealing.
29				Not able to sell to my customers.
30				Rather bitter in taste, meats were small and dark in color. Not very marketable in this area (NE).
31	50 degrees.			Unacceptable to replace hard shell clams but product if grown to 3"+ possible market for processing, canning, etc.
32				Not saleable in this area.
33	Temp @ time of arrival 58 degrees.	First time I saw them, not very attractive.		First time I saw them, not very attractive. Do not like the blood. Temp @ time of arrival 58 degrees. Package needs more ice. Product should be 40 degrees or below.
34				
35	Warm cooler – product OK!		Less brown than blood ark.	Better than blood arks – they did not steam open after 10 minutes of hard steaming. Actually had to pry open the shells to get them open. Way too much cooking time and work! The other had a much better “steamed” texture, but was so hard to get to. Overall I would rate the ponderous ark higher in every category except cooking time. I only steamed; maybe others had better luck with micro, broil,



Obs. No.	Condition	Appearance	Color	General Reactions
				etc. Hope people did broil, micro. Good luck!
36	Cool – in good shape.		Dark.	More long than round and meat more...like blood.
37			Red blood color.	Did not like the taste. Bitter and had an aftertaste.
38		Who wants to eat a clam with fur?	Meats are light to dark brown.	Who wants to eat a clam with fur? Some clams too small, the small clams had no black on them and were tender. It seems you sent three different species.
39			Definitely a blood clam.	I feel these are probably a more pleasant clam to look at and possibly a higher quality clam than the blood ark.
40				
41		Fuzzy appears dirty.	Dark.	Fuzzy appears dirty. Do not see a market in my area.
42				Raw and steamed OK, prefer steamed vs. raw or baked.
43		Like inside of shell's appearance – outside looked dirty to me and makes me think of bacterial environment and costly scrubbing.	No used to appearance – takes some getting used to.	It would take prior marketing tools and efforts to sell them. After 30 years selling full line seafood – this seems like an Asian item. Tough visually, can be decent flavor if you get past visual. Overall, raw shucked appearance hard to stomach, I eat raw oysters on the ½ shell for breakfast frequently.
44				
45				
46				They're no substitute for necks. Not likely to be popular here.
47				
48				Have customers with interest.
49				Too strong of taste compared to the blood ark clams.
50				
51				They did not open upon steaming.
52	Clams have good shelf life.		Too dark.	Have no established market for clam. Some use among Asian communities. Too dark for most clam consumers. Consumers want light-colored meat. Even yellow turns them away. They connect dark with a negative – something wrong!

**APPENDIX D**



## NUTRITIONAL ANALYSES

### Procedure

Comprehensive nutritional analyses were conducted for the Blood Ark clam and the Ponderous Ark clam. Samples of cultured ark clams were collected from their respective growing areas in St. Augustine (east coast of Florida) and Cedar Key (west coast of Florida). One hundred grams of meat (wet weight) were shucked for each ark clam species. The meat samples were delivered in coolers to an accredited private food-testing laboratory in Gainesville. Official methods were used following the AOAC (Association of Official Analytical Chemists) Official Methods of Analysis (Horwitz, 2002).

### Blood Ark Clams

The nutrition facts and labeling for cultured Blood Ark clams are provided below (Appendix D, Figure 1). These facts are determined for a serving size of 100 grams of raw, edible portion. This serving is low in calories (35) and total fat (0.5 g) and high in protein (7 g). Cholesterol is relatively low (35 mg), with the serving portion representing 12 percent of the daily value. There is no detectable carbohydrate (0 g) in this portion. In terms of percent daily value, a serving of Blood Ark clams provides six percent of Vitamin A, two percent of Vitamin C, and six percent of calcium. Blood Ark meats are high in iron (70% of daily value), which is most likely associated with the presence of hemoglobin and erythrocytes in the clam meats. Of note is the high sodium content (740 mg) that represents 31 percent of the daily value. Even for a saltwater mollusk, which is a suspension feeder, this level is particularly high. . One plausible explanation for this may be that the meat sample (wet weight) contained fluids from within the shells. These trapped fluids may have abnormally increased the sodium content.

### Ponderous Ark Clams

The nutrition facts and labeling for cultured Ponderous Ark clams are provided below (Appendix D, Figure 1). These facts are determined for a serving size of 100 grams of raw, edible portion. Like the Blood Ark clams, this serving is low in calories (50) and total fat (1.0 g), and even higher in protein (11 g). Cholesterol is higher than in the Blood Ark sample at 55 mg, representing 18 percent of the daily value. There is little carbohydrate (1 g). In terms of percent daily value, a serving of Ponderous Ark clams provides six percent of Vitamin A, four percent of Vitamin C, and ten percent of calcium. Ponderous Ark meats are also high in iron (50 percent of daily value), again most likely associated with the blood pigment content. Although the sodium content (480 mg) is lower than that for the Blood Ark clams, it is still relatively high representing 20 percent of the daily value.

### Comparison with Hard Clams

A nutritional analysis for the hard clam *Mercenaria mercenaria* was obtained from the Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing. Approximate nutritional values for four ounces (114 grams) of raw, edible portion consisted of the following: Calories-80; Calories from fat-10; Total Fat-

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1 gram; Saturated Fat-0 gram; Cholesterol-45 milligrams; Sodium-65 milligrams; Carbohydrate-0 gram; Protein-18 grams; Calcium-4 percent Recommended Daily Intake; and, Iron-20 percent Recommended Daily Intake. Information on Vitamin A and Vitamin C values was not available.

When comparing these hard clam values with those obtained for the ark clams, the hard clam is slightly higher in calories and protein, but similar in total fats, cholesterol and total carbohydrate. Greater differences between the hard clam and ark clams are found in the iron and sodium values. Ark clams provide two to three times the percent daily values for iron than hard clams, whereas ark clams contain ten times the amount of sodium than hard clams. Like the hard clam and other molluscan shellfish, ark clams are a nutritious and excellent source of protein. Ark clams are especially good sources of iron and calcium. However, based on these results consumers who must restrict their intake of sodium should take these nutritional facts into consideration or reduce their portion size.

Appendix D, Figure 1. Nutrition Facts for Blood Ark Clams (left) and Ponderous Ark Clams (right).

<b>Nutrition Facts</b>	
Serving Size (100g)	
Servings Per Container	
Amount Per Serving	
<b>Calories</b> 35	Calories from Fat 5
% Daily Value*	
<b>Total Fat</b> 0.5g	<b>1 %</b>
Saturated Fat 0g	<b>0 %</b>
<b>Cholesterol</b> 35mg	<b>12 %</b>
<b>Sodium</b> 740mg	<b>31 %</b>
<b>Total Carbohydrate</b> 0g	<b>0 %</b>
Dietary Fiber less than 1 gram	<b>4 %</b>
Sugars 3g	
Protein 7g	
Vitamin A 6%	• Vitamin C 2%
Calcium 6%	• Iron 70%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Saturated Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g
Calories per gram:	
Fat 9 • Carbohydrate 4 • Protein 4	

<b>Nutrition Facts</b>	
Serving Size (100g)	
Servings Per Container	
Amount Per Serving	
<b>Calories</b> 50	Calories from Fat 5
% Daily Value*	
<b>Total Fat</b> 1g	<b>1 %</b>
Saturated Fat 0g	<b>0 %</b>
<b>Cholesterol</b> 55mg	<b>18 %</b>
<b>Sodium</b> 480mg	<b>20 %</b>
<b>Total Carbohydrate</b> 1g	<b>0 %</b>
Dietary Fiber less than 1 gram	<b>4 %</b>
Sugars 3g	
Protein 11g	
Vitamin A 6%	• Vitamin C 4%
Calcium 10%	• Iron 50%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Saturated Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g
Calories per gram:	
Fat 9 • Carbohydrate 4 • Protein 4	

**APPENDIX E**



## SHELF LIFE EVALUATION

Molluscan shellfish are typically shipped as live shellstock and adequate shelf life is an important product attribute. Federal regulations require that live mollusks be placed in refrigerated storage (<45°F) within a predetermined time/temperature harvest matrix in order to reduce probable levels of *Vibrio* bacteria (FDA, 2003). For these reasons, the shelf life of live Blood Ark and Ponderous Ark clams was investigated to assure product quality and safety.

### Procedure

To determine the survival of these two ark clam species in refrigerated storage, evaluation of shelf life was conducted in April 2004. Procedures followed those developed by Applewhite et al. (1996) and Otwell (1998) for determining shelf life of hard clams *Mercenaria mercenaria*. Blood Ark clams were harvested from a commercial shellfish aquaculture lease located in the Intercoastal Waterway on the east coast of Florida at 8:00 AM on March 31, whereas Ponderous Ark clams were harvested from a commercial lease in the Gulf of Mexico on the west coast of Florida at 9:00 AM on the same day. Bottom water temperatures at the time of harvest were recorded. Immediately post harvest, ark clams were transported in coolers under ambient conditions to the Florida Fish and Wildlife Conservation Commission's marine laboratory in Cedar Key. At 1:00 PM ark clams were received at the laboratory and placed under tempering conditions at 68°F following protocols defined in the National Shellfish Sanitation Program, Model Ordinance, Guide for the Control of Molluscan Shellfish, VIII@.03 OPTION 1.E (FDA, 2003) and the Comprehensive Shellfish Control Code, Rule Chapter 5L-1.013(3)(b), Florida Administrative Code. During tempering, 100 ark clams were randomly selected from each species, of which a sub-sample of 25 was measured and weighed. Each ark clam sample of 100 was then placed into polyethylene tubular netting, which is typically used by shellfish dealers in bagging and transporting hard clams.

As defined in the harvest time/temperature matrix per Rule Chapter 5L-1.008(5), FAC, molluscan shellfish must be placed into refrigeration within 12 hours of the time of harvest during the month of April. If tempering is included as an alternative post-harvest process, then the time to refrigeration can be extended up to 16 hours from the time of harvest. Ark clams were placed into a thermostat-controlled refrigerator set at the standard storage temperature of 45°F on March 31 at 7:30 PM. Air temperatures were recorded inside the refrigerator using a minimum/maximum thermometer. The ark clams were checked daily for survival with the exception of two days during the evaluation period. Gapped ark clams were determined to be "commercially dead" when they did not respond by closing their shell to specified agitation, or tapping, after the ark clams were held for a short time at room temperature. Dead ark clams were counted and removed from the sample bags. The general conditions of the ark clams during storage were also noted. The evaluation was conducted until 50 percent of the ark clams died. Percent survival for each ark clam species was determined.

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Blood Ark Clams

Water temperature at the time of harvest of the Blood Ark clams was 67°F. The clams used in the Blood Ark sample averaged 1 7/8” in shell length, 1 1/4” in shell width and 12.6 per pound. During the shelf life evaluation, minimum air temperatures in the refrigerator averaged 41.4°F (+/-3.3°F) and maximum air temperatures averaged 52.4°F (+/-2.5°F). The overall average daily temperature was 46.9°F (+/-2.7°F). The noncommercial refrigerator used in this study was not able to maintain air temperatures consistently below 45 °F.

The first Blood Ark mortality occurred on the fourth day of the evaluation. Mortalities were not noted again until the tenth day when five Blood Ark clams did not respond to agitation. Mortalities then occurred almost daily, with the number of mortalities increasing rapidly after the 19<sup>th</sup> day. On Day 23, the cumulative number of dead Blood Ark clams was 57 and the shelf life evaluation was terminated (Appendix E, Table 1).

Appendix E, Table 1. Number of Blood Ark Clam Mortalities in Refrigerated Storage.

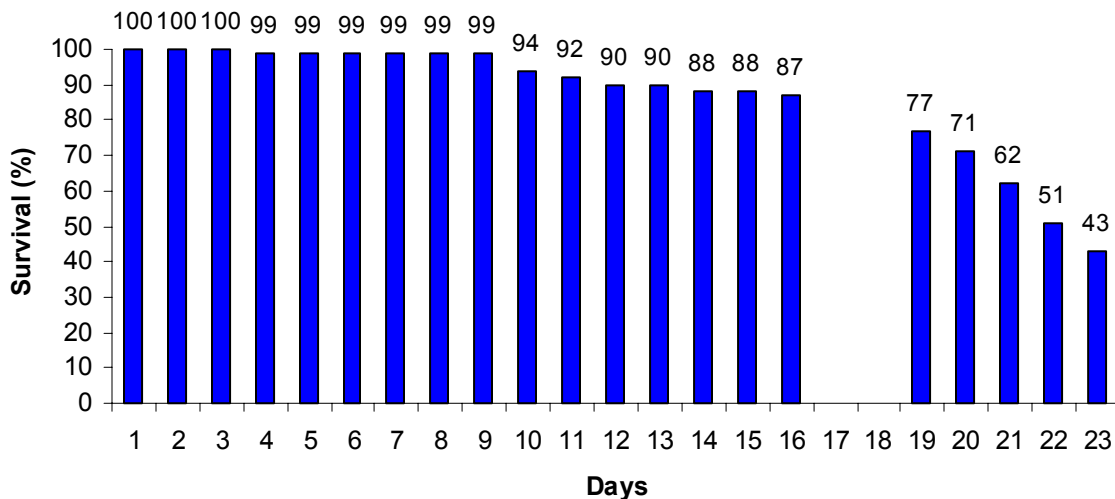
Date	Day	Number Dead -----n-----	Number Cumulative Dead -----n-----
3-31-2004	0	0	0
4-01-2004	1	0	0
4-02-2004	2	0	0
4-03-2004	3	0	0
4-04-2004	4	1	1
4-05-2004	5	0	1
4-06-2004	6	0	1
4-07-2004	7	0	1
4-08-2004	8	0	1
4-09-2004	9	0	1
4-10-2004	10	5	6
4-11-2004	11	2	8
4-12-2004	12	2	10
4-13-2004	13	0	10
4-14-2004	14	2	12
4-15-2004	15	0	12
4-16-2004	16	1	13
4-17-2004	17	-	-
4-18-2004	18	-	-

**Shellfish Industry Survey**

Date	Day	Number Dead -----n-----	Number Cumulative Dead -----n-----
4-19-2004	19	10	23
4-20-2004	20	6	29
4-21-2004	21	9	38
4-22-2004	22	11	49
4-23-2004	23	8	57
Total	23	57	57

Survival of Blood Ark clams in refrigerated storage was 99 percent or greater during the first nine days of the evaluation. Survivals dropped below 90 percent and 50 percent after Days 13 and 23, respectively (Appendix E, Figure 1). After the first week of the evaluation, liquid began accumulating in the bottom of the tray holding the Blood Ark bag. The tray was wiped clean daily thereafter. In addition, gaping occurred frequently in the live Blood Ark clams and agitation was required before they would close. The remaining live ark clams at the end of the evaluation sounded “hollow” and a strong odor was detected. A commercial mortality of greater than five percent would be considered unacceptable by the shellstock shipper industry, thus the shelf life of Blood Ark clams harvested under spring conditions may be limited to ten days. During warmer water temperatures experienced in summer months, shelf life may be further reduced, thus limiting shipment of live Blood Ark clams during that time period.

Appendix E, Figure 1. Survival of Blood Ark Clams in Refrigerated Storage.


Ponderous Ark Clams

Water temperature at the time of harvest of the Ponderous Ark clams was 68°F. The clams used in the Ponderous Ark sample averaged 2” in shell length, 1 3/8” in shell



width and 10.5 per pound. During the shelf life evaluation, minimum air temperatures in the refrigerator averaged 41.4°F (+/-3.3°F) and maximum air temperatures averaged 52.4°F (+/-2.5°F). The overall average daily temperature was 46.9°F (+/-2.7°F). The noncommercial refrigerator used in this study was not able to maintain air temperatures consistently below 45 °F.

The first Ponderous Ark mortality occurred on the twenty-third day of the evaluation. This was the same day that the Blood Ark evaluation was concluded since over 50 percent of those ark clams had died. It was decided to terminate the Ponderous Ark evaluation on the same day (Appendix E, Table 2).

Appendix E, Table 2. Number of Ponderous Ark Clam Mortalities in Refrigerated Storage.

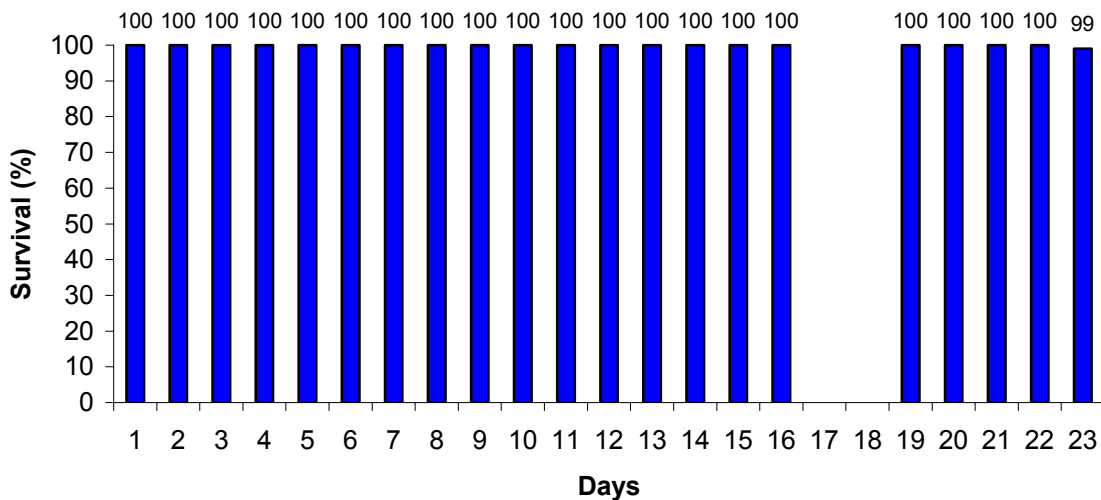
Date	Day	Number Dead -----n-----	Number Cumulative Dead -----n-----
3-31-2004	0	0	0
4-01-2004	1	0	0
4-02-2004	2	0	0
4-03-2004	3	0	0
4-04-2004	4	0	0
4-05-2004	5	0	0
4-06-2004	6	0	0
4-07-2004	7	0	0
4-08-2004	8	0	0
4-09-2004	9	0	0
4-10-2004	10	0	0
4-11-2004	11	0	0
4-12-2004	12	0	0
4-13-2004	13	0	0
4-14-2004	14	0	0
4-15-2004	15	0	0
4-16-2004	16	0	0
4-17-2004	17	-	0
4-18-2004	18	-	0
4-19-2004	19	0	0
4-20-2004	20	0	0
4-21-2004	21	0	0

## Shellfish Industry Survey

Date	Day	Number Dead	Number Cumulative Dead
		-----n-----	-----n-----
4-22-2004	22	0	0
4-23-2004	23	1	1
Total	23	1	1

Survival of Ponderous Ark clams in refrigerated storage was 100 percent during the first 22 days of the evaluation. Only on Day 23 did the survival drop to 99 percent. The majority of the Ponderous Ark clams remained tightly closed throughout the evaluation with no liquid accumulating on the bottom of the tray holding the Ponderous Ark bag. There was no gapping observed in the remaining live ark clams and no odors were detected (Appendix E, Figure 2).

Appendix E, Figure 2. Survival of Ponderous Ark Clams in Refrigerated Storage.



### Comparison with Hard Clams

A baseline for the survival of Florida farm-raised hard clams during refrigeration was obtained for product harvested from commercial aquaculture leases in the Gulf of Mexico during April through October 1997 (Otwell, 1998). In April, 100 percent of the hard clams survived for seven days after placement in refrigerated storage. After ten days, the survival of hard clams dropped to 90 percent. In this study, the Blood Ark clams showed similar responses to refrigerated storage as hard clams. It may be that like hard clams, survival of Blood Arks may be reduced when harvested during the warmer summer months. However, extending the tempering protocol to its full duration of 16 hours may help prolong the refrigerated shelf life of Blood Arks as it has with hard clams. The tolerance of live Ponderous Ark clams to refrigerated temperatures exceeds that observed for hard clams and other molluscan shellfish, such as oysters. These results demonstrate that commercial distribution of live shellstock of both ark clam species is achievable.



Alternative harvesting, handling and storage techniques, such as tempering, used to increase survival of hard clams in refrigerated storage when harvest water temperatures exceed 80°F should also be considered for the Blood Ark clam.