Intensive Technical Assistance for the Gulf and South Atlantic Shrimp Industry: A Final Report Outlining the Work Undertaken and Achievements To Date

(Award Number 2005-48605-03347)

Prepared for

The Southern Region Risk Management Education Center
Stephenville, Tx

Kenneth W. Stokes – Director

Prepared by Extension Specialists in the Departments of Agricultural Economics and Wildlife & Fisheries Sciences

Texas AgriLife Extension Service
Sea Grant College Program
The Texas A&M University System

Texas AgriLife Extension Service • Edward G. Smith – Director • The Texas A&M University System • College Station, Texas
Sea Grant College Program • Robert R. Stickney – Director • Texas A&M University • College Station, Texas

Intensive Technical Assistance for the Gulf and South Atlantic Shrimp Industry: A Final Report Outlining the Work Undertaken and Achievements To Date
(Award Number 2005-48605-03347)

Prepared for

The Southern Region Risk Management Education Center
Stephenville, Tx

Kenneth W. Stokes – Director

February, 2010

Prepared by

Michael G. Haby[a], Gary L. Graham[b], and Russell J. Miget[c]

TAMU-SG-10-202

---

a. Professor & Extension Economist – Seafood, Department of Agricultural Economics, Texas AgriLife Extension Service, Sea Grant College Program, Texas A&M University. Contact information: Texas AgriLife Research and Extension Center, 10345 State Hwy. 44, Corpus Christi, Tx 78406-1412. Tel: 361/265-9203, Fax: 361/265-9434, E-mail: m-haby@tamu.edu.

b. Professor & Marine Fisheries Specialist, Department of Wildlife and Fisheries Sciences, Texas AgriLife Extension Service, Sea Grant College Program, Texas A&M University. Contact information: P.O. Box 1125, West Columbia, Tx 77486. Tel: 979/345-6131, E-mail: glgshrimp@embarqmail.com.

c. Professor & Environmental Quality Specialist, Department of Wildlife and Fisheries Sciences, Texas AgriLife Extension Service, Sea Grant College Program, Texas A&M University. Contact information: Texas A&M University – Corpus Christi, Carlos Truan Natural Resources Center – Suite 2800, 6300 Ocean Dr., Corpus Christi, Tx 78412. Tel: 361/825-3460, Fax 361/825-3465, E-mail: russ.miget@tamucc.edu.

Table of Contents

Executive Summary

Introductory Remarks

As Intensive Technical Assistance (ITA) began for the shrimp industry, dockside prices had declined by 58% from 2000, fuel prices were sharply escalating, and at the median, a gallon of diesel was required to land about 14 oz. of shrimp. Though the shrimp industry won all six antidumping cases in 2005, imports continued relatively unabated. Specifically, shrimp imports grew by an average of 15% each year between 2003 and 2008. Conversely, import growth averaged 2.8% per year between 1990 and 2002.

Improving Economic Performance with ITA Funds

ITA efforts for the beleaguered shrimp industry sought to improve the economic performance of offshore shrimp fishing by focusing on both contributors to profitability: maximizing revenues while driving avoidable costs out of the enterprise.

On the revenue side, work commenced to review, specify, and verify every step that occurs on the back deck once shrimp are landed to create a science-based "handling recipe" that would maximize the fraction of top-quality shrimp producers offloaded at the end of each cruise. In the short run, the best a producer could expect from implementing this recipe was to minimize deductions for substandard quality shrimp. Ultimately the objective was to move wild, domestic shrimp to the top of the price-point hierarchy in the American marketplace by, among other things, ensuring that wild shrimp appear as good as they taste and were packed on par with high-grade imports. Of course, this objective would take a concerted, industry-wide, certification and marketing campaign.

On the cost side, ITA project directors commenced a fishery-wide cooperative research effort with elite shrimp producers to evaluate a new type of trawl door that uses less resistance to spread the nets. Less resistance means fewer RPM necessary to maintain towing speed which translates into reduced fuel use. Nominal diesel prices reached $4.02/gal. in July 2008. In the short run, reducing fuel consumption while harvesting the same quantity of shrimp would help remaining producers better absorb other economic shocks to the production enterprise. Unfortunately, the latest economic shock, historically-low dockside prices, resulted from the mortgage/banking debacle surfacing in late 2008 and the ensuing recession with record unemployment levels.

Results and Impacts Generated with ITA Funds

<u>Improving landed shrimp quality.</u> Research efforts focused on answering industry questions about the efficacy of various approved additives that prevent discoloration and how best to protect frozen shrimp from dehydration during the cruise. Research trials documented that when operators begin with high-quality shrimp, any approved additive, applied immediately or at the dock, can ensure top visual quality; not just during 2 months of frozen storage but also after 4 days under refrigeration. Work also demonstrated that dipping brine-frozen shrimp in clean water prior to placing them in the frozen storage hold provided roughly ten times the volume of glazing around the IQF shrimp compared to the glaze created by adding sugar to the brine tank.

<u>Reducing fuel consumption and expense.</u> Cooperative research with elite producers documented fuel savings that ranged from 10% to 39% with savings at the 25th percentile amounting to 20%, while fuel savings at the median and 75th percentile respectively were 24% and 29%. Roughly 80% of the Cameron County fleet (132 vessels) switched to the new fuel-efficient gear in early 2008. In just two years, county-wide fuel savings were estimated to be 4.88 million gallons valued at $12.1 million. In addition to immediate reductions in fuel expense, the fuel-saving trawl gear also reduces the frequency of oil and filter changes and will halve the expense of top-end and major overhauls over the estimated 16-year engine life.

Outreach efforts about the fuel-saving gear have spawned important pilot programs by third parties. For example, laws in two gulf states were changed to permit use of the fuel-saving trawl gear. One NGO now offers a pilot program to cover half the cost of converting to the new trawl gear, an $8,850 saving per vessel. This is a godsend since most financing historically available to the shrimp industry vanished with the advent of the revenue crisis. An eco-marketing organization that supplies sustainably produced, *"environmentally-friendly"* seafoods to retail establishments has started a pilot effort with selected, local producers to market wild shrimp harvested with the fuel-saving trawl gear and required TEDs and BRDs. Quoted prices by this niche distributor have been much higher than those offered by the larger market. This suggests that participating operators may finally begin to grow their profit margins with the combination of historically-high catch rates coupled with higher dockside prices.

Intensive Technical Assistance for the Gulf and South Atlantic Shrimp Industry: A Final Report Outlining the Work Undertaken and Achievements to Date

Introduction, Approach & Current Operating Conditions in the Shrimp Industry

Introduction

Improving the future economic performance of offshore shrimp fishing across the Gulf and South Atlantic states was the goal of the Intensive Technical Assistance (ITA) program developed and implemented by faculty with the Texas A&M University System. On the revenue side, work was undertaken to develop those science-based competencies required to land defect-free shrimp so that producers could receive maximum market prices. On the cost side, efforts focused on reducing fuel consumption and expense by locating and adapting trawl gear (i.e., the complement of (a) webbing made into nets and (b) otter boards also known as trawl doors or doors) never before used in the Gulf and South Atlantic shrimp fishery.

As discussions began with other Sea Grant Extension faculty in Alabama, Louisiana, and Mississippi about the direction the ITA program should take, we were asked to assume regional responsibility for the topics of quality improvement and fuel conservation.[1] To support this regional responsibility, ITA funds were pledged from these three state Sea Grant Extension Programs and their collective generosity enabled us to prepare a program budget of $312,000; $96,000 more than the funding formula suggested we should receive. With these additional funds, we were able to expand our efforts to shrimp fishermen who work across the entire Gulf of Mexico as different shrimp species come into their peak-harvesting seasons.

This report presents a comprehensive review of the activities undertaken to support the overall project goal delineated along the topical tracks of quality improvement and fuel conservation. To set the stage for the detailed discussion about the activities undertaken, we begin by reviewing the approaches taken to support the project goal including the use of applied research conducted ahead of outreach activities. We are extremely gratified with several notable achievements as a result of ITA efforts, and these will be presented in the body of the report as part of each programmatic track. In addition, our ITA-funded efforts have spawned some impressive outcomes and impacts by others not associated with the ITA process. We call these "third-party initiatives" which are best described as next steps in the continuum of work necessary to improve the future economic performance of what, historically, was America's most valuable commercial fishery.

Not all of our work was as successful as we hoped. We take responsibility for those unsuccessful elements, but one distraction for our target audience has been the crushing operating conditions offshore operators have faced since late 2001. These conditions and the adaptations surviving operators have made out of necessity contributed to some expectations not being met prior to the ending date of this effort. A summary of these operating conditions concludes this section.

Approach Used in Texas' Intensive Technical Assistance Efforts

The Intensive Technical Assistance program funded by USDA was a structured outreach education and training program for Trade Adjustment Assistance applicants. However, helping shrimp fishermen improve shrimp quality and reduce fuel consumption – classic outreach work designed to help producers meet

---

1. In Alabama the fisheries specialist was scheduled to retire within the first few months of ITA efforts commencing, and felt Alabama fishermen would be better served by our conducting ITA efforts. The ITA coordinator at LSU offered to contribute a portion of their funds if we would produce the educational deliverables for Gulf of Mexico shrimp producers. In Mississippi, the fisheries specialist was still attempting to repair catastrophic damage to his house and personal property generated by Hurricane Katrina.

objectives with fewer steps, less expense, etc. – required that we begin with outputs from applied research activities that would subsequently serve as raw materials for the education and training process. This section discusses the reasons why these two tracks were addressed and outlines the applied research efforts that supported them.

The Importance of Improved Quality

Several issues pointed to quality improvement as one theme for our ITA work. Aside from the importance of improving output quality in a competitive market, one of the primary reasons for choosing quality improvement was our desire to help producers compete against imports while minimizing additional expenditures at the vessel level during a disastrous economic period in industry history. In his groundbreaking text *"Quality is Free,"* Phillip Cosby noted that in broad-scale examinations of the quality management and improvement process across different industries, investment in the complement of equipment necessary to produce or manufacture a *"quality"* item had already been made. The factor commonly limiting quality is lack of proper detailed management direction about the policies, procedures, and practices that employees must use to ensure ending quality. This pattern observed by Cosby also exists in the offshore shrimp fishery. Most vessels in the offshore shrimp industry are equipped with the assets required to produce and offload premium-quality shrimp. The element missing in some operations has been a lack of understanding about how best to use those assets so that the fraction of premium-quality shrimp landed is maximized. In manufacturing, the costs of poor quality include additional scrap, rework, warranty expense, etc. In the wild shrimp industry, the costs of poor quality at the vessel level are immediately reflected in sharp deductions off the current market price for products not meeting threshold requirements.

Importantly, the threshold requirements among corporate purchasers have been *"racheted up"* in recent years because more premium-looking shrimp are available. Quality standards developed thirty or forty years ago by the domestic shrimp industry have been eclipsed by more aggressive standards made possible by the large, vertically-integrated shrimp farming and processing operations across Southeast Asia and Central America. Today, farmed shrimp accounts for roughly 55 percent of total, category imports. Shrimp originating from these large, integrated operations *"look"* all but perfect across the attributes of <u>product condition</u> and <u>pack quality</u>.

Beginning in 2003, leadership in the Gulf and South Atlantic shrimp industry suggested that industrial stability and vessel profitability may best be ensured by producing and marketing a premium, specialty shrimp with attributes that cannot be duplicated in ponds. Food quality is comprised of both intrinsic (or inherent) attributes and extrinsic components (i.e., those transformations, activities, treatments, etc. performed on the product). Perhaps the best example of an intrinsic or inherent attribute in wild shrimp is their unique marine or *"briny"* flavor which distinguishes them from the vast majority of shrimp available in the U.S. market.[2] Extrinsic <u>product condition</u> elements controlled by fishermen include (a) complete, undamaged, non-discolored shrimp tails with a mild aroma, (b) no indication of freezer burn, or (c) other signs suggesting

2. Marine foods are harvested from waters containing 3.5% salt, so many feel that saltiness would be the predominant flavor in ocean-harvested products. <u>This notion is incorrect.</u> Fish and crustaceans harvested from the marine environment are low-sodium foods! A 3.5 oz. (100 gm.) serving of chinook salmon contains 60 mg. of sodium, 100 gm. of boiled shrimp contains 148 mg. of sodium, and a 100 gm. serving of broiled T-bone contains 67 mg. of sodium. Comparing these three examples against the maximum Daily Reference Value (DRV) established for sodium of 2,400 mg. indicates that (a) salmon would account for 1.6% of DRV, (b) shrimp would contribute 6% to DRV, and (c) beef would contribute roughly 2% to DRV. Conversely, two frankfurters (100 gm.) contain 980 mg. of sodium. Even without the addition of mustard, ketchup, pickles, or a bun, this processed product would contribute 41% to the maximum DRV for sodium.

overuse of preservation compounds or salt.[3] Since shrimp are customarily sold by count size, the extrinsic components of pack quality typically controlled by the processor include (a) accurate weights, (b) accurate counts (i.e., number of tails per pound expressed as intervals such as 16-20, 26-30, 31-40, etc. according to customary market convention), and (c) the uniformity of individual shrimp comprising a stated count size (i.e., the ratio of the largest shrimp to the smallest shrimp expressed on a weight basis). In addition, pack quality that meets current world standards also requires 100 percent useable shrimp without (a) shrimp *"pieces"* in the package (a piece is defined as a shrimp tail possessing less than five segments), (b) unuseable, "damaged" shrimp (which could include physical damage like soft-shelled shrimp, mashed shrimp or discolored products), or (c) shrimp exhibiting other manifestations of poor product condition like advanced melanosis (i.e., "black spot"), off-odors, etc.

Realizing the goal of establishing wild, domestic shrimp as a premium-priced product requires both intrinsic and extrinsic quality elements. Flavor alone, an intrinsic trait, will not establish domestic shrimp as a top-tier product worthy of premium prices unless the extrinsic components are also addressed. Products that cannot meet the new standard for product condition and pack quality will be relegated to a lower tier within the market, and be accordingly priced. One example of what happens when a product has one unique, intrinsic quality attribute but cannot meet extrinsic expectations occurred in 2003. That summer, a great-tasting shrimp piece was worth just 38 percent of what a whole shrimp tail would have fetched in the market.[4]

Research to identify quality improvement procedures and practices. The applied, cooperative research effort specified in our ITA proposal was to start by soliciting producers who could "groundtruth" the quality improvement recommendations made by the project directors under previous technical assistance efforts. However, after numerous meetings with fleet owners, owner-operators, and processors, we concluded that *"the only standard in back-deck operational procedures was no standard."* Each producer felt that his was the correct approach (yet different in some way from the other potential cooperators we interviewed) when in fact individual descriptions of back-deck handling and management of the brine freezing step seemed more a function of convenience, custom, and recall than adoption of a "recipe-based system" predicated on prior scientific evaluation. After a series of meetings with prospective cooperators, we wondered precisely what the cadre of producers would be "groundtruthing" to support this aspect of the project.

Another topic also surfaced in those industry conversations which confounded a cooperative quality improvement study. Several fleet owners prevent crews from taking food-grade additives on cruises. Those fleet owners do not trust the crews to use these compounds properly at the time of harvest, but instead rely on the brine freezing and cold-storage holds of modern trawlers to preserve the shrimp until they can be treated at the dock. At first glance, this approach of delaying treatment seemed contrary to conventional wisdom about the efficacy of using preservation additives sooner after death rather than later. We also encountered producers who incorrectly used one food-grade additive which, according to the manufacturer, would compromise the expected results.

To determine the next logical step given our concerns, Dr. Russell Miget – an ITA project director, a professor in the Wildlife and Fisheries Sciences Department, and a past-president of the Seafood Section of

---

3. Preventing defects depends upon (a) tow times (i.e., the length of time shrimp are allowed to accumulate in the nets before the bags are emptied on the back deck), (b) the quantity and composition of by-catch, and (c) the host of back-deck activities once shrimp are landed. Back-deck activities include (a) sorting shrimp from non-shrimp, (b) heading shrimp (most of the time in the offshore fishery), (c) containerizing shrimp for subsequent treatment like washing, dipping in solutions of approved, food-grade additives, (d) immersion brine freezing, and (e) placement in the frozen storage hold below deck. How each of these activities is undertaken has a significant effect on product condition and visual appearance.

4. Such deductions for substandard product have always been routine practices, not isolated events. However, with a greater proportion of "visually perfect" farmed shrimp entering the U.S. market scrutiny for various defects has intensified.

the Institute of Food Technologists – reviewed the body of work related to back-deck processing and immersion brine freezing. He found that much of the work which established the current on-board handling protocols for shrimp vessels was carried out between the late seventies and early eighties when at-sea, immersion brine freezing technology was in its infancy.[5] Thus, the entire on-board brine freezing process – from initial preparation of the brine solution at the dock, through ingredient recharge during the cruise, to disposal of the brine solution and cleaning of the immersion freezer at the end of the trip – needed to be reviewed and, if necessary, revised. Every aspect of currently-recommended procedures was reassessed, based largely on industry comments mentioned during the interview process. This reassessment was carried out in the laboratory using shrimp which, once caught, were packed in ice and offloaded the same day, without the introduction of any preservation additives.

As part of the response to the revenue crisis in the shrimp industry, the National Marine Fisheries Service funded a certification and marketing program for the wild, domestic shrimp industry in 2005 known as Wild American Shrimp, Inc. (WASI). Leaders of this organization stated that it would be essential to have the litany of policies, procedures, and practices available to help producers improve the landed quality of their shrimp which would be supported by a certification and promotional effort. This added impetus to our: (a) confirming the effects of different handling and batching procedures, (b) assessing the use and effectiveness of varied food-grade additives, (c) exploring the effectiveness of immediate vs. delayed treatment with those additives, (d) use of cryoprotectants, etc. Two outcomes were expected from this ITA track. The first was to provide producers with the knowledge base that would enable them to offload a maximum fraction defect-free shrimp. The second was to provide WASI with a standard operating procedure that could become part of the domestic shrimp industry standard; one of the goals this organization set for itself.

Reducing Fuel Consumption

As we began addressing shrimp industry viability concerns through the ITA process, the prices received for shrimp continued to fall,[6] the prices paid for fuel were escalating,[7] and – at the median – a gallon of fuel was required to land just over ¾ lb. of shrimp.[8] Thus, driving avoidable costs out of the enterprise while still catching the same quantity of shrimp was deemed a critical contributor to economic viability for those

---

5. For example, much of the on-board demonstration work involved the use of small-volume freezing systems, often with no means of circulating the refrigerated brine. Because 40 percent of the annual harvest occurred between mid-July and the end of September, brine-freezing systems were typically "shock loaded" with excessive volumes of shrimp harvested during the hottest months of the year. This shock loading sharply increased freezing time. So long as unfrozen product is immersed in a saturated brine solution, moisture is removed from the muscle and replaced with salt. In contrast, today's brine-freezing systems utilize a much larger volume, are equipped with more refrigeration capacity, and use circulation systems.

6. A review of average, annual, prices received by Texas shrimp producers in 2000, 2003, and 2006 vividly illustrates the drop in ex-vessel prices. In 2000, fishermen received $9.18/lb. for under-15 count shrimp. By 2003 these shrimp were worth $5.68/lb.; a drop of $3.50 (38%) while 2006 reflected a price of $5.09/lb., a 45% decline from 2000. Ex-vessel prices for 21-25 count tails averaged $5.67/lb. in 2000, $3.85/lb. in 2003, and $2.80/lb. in 2006. Expressed in percentage terms, 21-25 count tails declined by 32% between 2000 and 2003 while the 2006 price was just over half of the annual 2000 ex-vessel price. First-of-the season 41-50 count tails fell from $3.94/lb. in 2000, to $2.14/lb. in 2003, to $1.66/lb. in 2006. On a percentage basis, 2003 reflected a 46% drop from 2000 while 2006 prices declined by 58% from those paid in 2000.

7. Between 2003 and 2005 diesel doubled to $2.00/gal. [http://tonto.eia.doe.gov/dnav/pet/hist/d220300002M.htm].

8. Based on information collected under a Standardized Performance Analysis (SPA) of Texas offshore shrimp producers between 1986 and 1997, offshore operators historically use between 58,775 and 73,485 gallons of diesel each year. These two values represent the 25th and 75th percentiles. Median, annual fuel use was 66,101 gallons. The SPA of shrimp producers provided a fertile data source that enabled us to compute various performance ratios that summarized financial position, financial performance, and operational efficiency. One example of operational efficiency was the ratio "pounds of shrimp sold per gallon of fuel used." Over the 12-year time frame, the computed, median value was 0.889 lb./gal. (or 14.2 oz. /gal.). This midpoint was bracketed at the 25th percentile value by 0.777 lb./gal. (or 12.4 oz./gal.) and at the 75th percentile value by 1.033 lb./gal. (or 16.5 oz./gal.).

remaining in the shrimp fishery. Trawl fisheries use large quantities of fuel to hunt and harvest targeted species, and the shrimp industry is no exception.

One way to reduce fuel consumption in trawl fisheries is to design (or adapt) trawl gear which creates less resistence once deployed. A trawl system is comprised of two main components: (a) the net system and (b) the otter boards (or trawl doors) that are attached between the net(s) and the main towing cables. Trawl doors spread the net(s) as the vessel moves forward. Fuel consumption increases when the trawl is deployed because the additional resistance from the fishing gear requires more RPM to maintain vessel speed. Both components of trawl systems – webbing and trawl doors – were considered as candidates for more fuel-efficient shrimp-fishing operations.

In the late eighties Gary Graham – an ITA project director and a professor in the Wildlife and Fisheries Sciences Department – began extensive industry evaluations with high-tensile-strength, small-diameter webbing, and found that these fibers were capable of reducing drag compared to nylon, the traditional webbing material used in the industry. The trade-off in opting for strong, small-diameter webbing was price. Spectra®, the small-diameter fiber with the highest tensile strength and abrasion resistance, was several times the price of nylon.[9] Today, Spectra® is a primary component in body armor for the military, and the current unit price of approximately $80.00 per pound has made it prohibitive for use in the seafood industry. Other new fibers on the market like Sapphire® – a braided, high-density polyethylene, is also a small-diameter, high-strength, abrasion-resistant webbing material – but it is more reasonably priced.

Evaluation of proprietary webbing materials is part of the historical record of research designed to generate efficiency gains in the Gulf and South Atlantic shrimp industry. However, the evaluation of more fuel-efficient trawl doors has been a much more recent consideration. With unit fuel prices doubling from $1.00 to $2.00 per gallon between 2003 and 2005, industry leaders began searching for trawl doors capable of spreading nets to their maximum width, but with less resistance. The preliminary search ended with Icelandic trawl doors that, by virtue of their curved surfaces, create a differential in hydrodynamic pressure between the inside and outside surfaces which spreads the nets.[10] Initial evaluation of these new trawl doors began in 2005 (ahead of ITA funding) with *"proof of concept"* testing aboard the F/V Isabel Maier, one of the trawlers in the Western Seafood fleet. Participants in those early sea trials were (a) Patrick Riley, General Manager of Western Seafood (Freeport); (b) Captain Manuel Calderón, a forty-year veteran of the Gulf shrimp fishery and the most productive Captain at Western; and (c) Gary Graham. In initial sea trials, the experimental doors spread the nets typically fished by Captain Calderón, but the evaluation team noted several issues that needed to be addressed before these new doors could be considered as (a) viable replacements for traditional trawl

---

9. Leaders in the shrimp industry were quite enthusiastic about the benefits Spectra® webbing offered, but the relatively low cost of fuel made adoption among fleets, which employ Captains and crew to operate the vessel, lower than expected. When asked about their decision to continue using nylon, many cited the concern for such high-priced webbing that could become entangled in bottom obstructions and would be lost.

10. Historically otter trawls were opened with flat boards or "doors" made of wood or aluminum. Traditional trawl doors used in the shrimp fishery are flat. Flat doors generate spreading power by creating directed resistance in the water column as the vessel moves forward. This directed resistance is created with a four-point chain-connection system whereby the leading face of the door (i.e., that plane which faces the vessel) is attached so that (a) a face of the rectangle sits somewhat perpendicular to the sea floor and (b) the leading face of each door points away from the towing cable by an angle of about 30 to 45 degrees (known as the angle of attack). With flat doors, the nets are spread by resistance of the door created with the angle of attack as it travels along the seabed. While traditional flat doors are effective at opening the nets, the additional resistance necessary to spread the nets requires more RPM from the engine which, in turn, requires more fuel. On the other hand, vented, cambered (i.e., curved like an airfoil) doors spread the net by virtue of a hydrodynamic design similar to a airplane wing. To spread an identical net with a set of cambered doors requires just under half the geometric area found in a flat door. Furthermore, the angle of attack with cambered doors is significantly smaller than that required for flat doors. The combination of (a) a much smaller geometric area and (b) the reduced angle of attack sharply decreases resistance of the door which allows the engine to maintain a constant towing speed, but with fewer RPM.

doors on the Western vessels or (b) ready for other producers to evaluate. Subsequent testing and modification by Riley, Calderón, and Graham addressed these deficiencies.

Improvements from the initial sea trials included: (a) use of a smaller-sized door than originally expected, (b) replacing the curved "shoes" found on the bottoms of stock doors (Figure 1) with flat "shoes" that resulted in more effective placement of net components on the seabed (Figures 2 and 3), (c) a bridle configuration that added vertical stability to the doors (Figure 3), and (d) design of a new sled with a buoyancy tank that slowed descent of the twin trawl system to the sea floor (shown in Figure 1 between the trawl doors and in Figure 4 during trawling operations).[11]

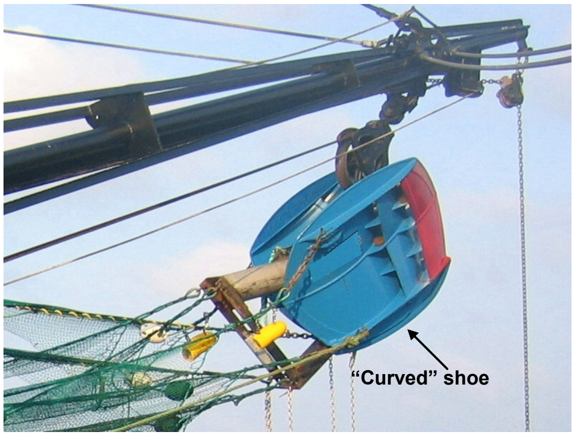


Figure 1. Original door design with a curved shoe that created instability during towing operations and an unacceptable shrimp loss

Figure 2. Retrofitted door with an "after market" shoe that increased stability on the sea floor and kept the net in contact with the bottom

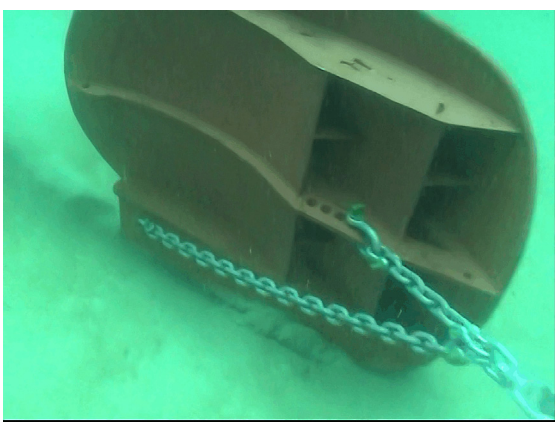


Figure 3. Cambered door showing bridle configuration attached to towing cable

Figure 4. Aft view of the sled with a buoyancy tank being towed between the inside and outside nets

11. If one net is towed on each side of the trawler, a pair of trawl doors is connected to the towing cables and the single net is connected to the these two doors. However, when two nets are towed on each side of the vessel, a sled or dummy door, is used as a third towing point, and is connected to the head rope and foot rope of the inside and outside nets to expand the total opening of a twin trawl. Ultimately reducing the size of the sled and constructing it with flat bar has negated the need for a buoyancy tank to slow descent; now the flat-bar sled slowly "skis" to the sea floor.

Cooperative research to evaluate the efficiencies of the new trawl gear. With ITA funding, the initial breakthroughs and subsequent improvements created with the vented, cambered doors in 2005 were subjected to broad-scale evaluation by elite fishermen across the Gulf and South Atlantic. ITA funds were used to purchase experimental trawl doors, Sapphire® webbing, and fuel-flow monitoring equipment.

This broad-scale evaluation phase had three objectives. First, fishermen who operate in different areas of the Gulf and South Atlantic were empowered to evaluate gear never before tested in their own "backyards" (i.e., the combination of (a) seabed conditions [mud or sand]; (b) water depth; (c) different net types and sizes for various targeted shrimp species; (d) various levels of horsepower, and (e) different, targeted shrimp species. Second, project directors anticipated that these elite cooperators would "spread the word" about the fuel-conserving nature of the new doors and braided Sapphire® webbing. The third objective was to create a cadre of "consulting elite fishermen" who could assist local fishermen with start-up problems associated with the new doors.

Using producer results, project directors were able to estimate a range of expected changes in fuel consumption other producers across the Gulf and South Atlantic may experience. The results of this cooperative research by fishermen enabled us to (a) produce various reference materials that summarized the findings of this effort as research results were generated and (b) subsequently conduct outreach training for Gulf and South Atlantic shrimp producers.

Industry Operating Conditions: 2002 – 2009

The Changing U.S. Shrimp Market

Domestic shrimp production averages roughly 200 million pounds a year, so any growth in consumption beyond that level must be supplied by imported product. For decades imports have been a growing contributor to U.S. shrimp supplies. However, in 2001 the U.S. began receiving record volumes of low-priced, farm-raised shrimp which precipitated an industry-wide revenue crisis.

Sharp increases in the volumes imported to the U.S. began occurring because of four conditions: (a) growing worldwide supplies of farm-raised shrimp; (b) stagnant growth in Japanese shrimp consumption; (c) sharply higher tariffs in the European Union (E.U.) for some market forms of shrimp from selected Asian countries; and (d) a zero-tolerance for farmed shrimp containing residues of banned antibiotics entering the E.U. that that included **destruction**, not simply rejection, of non-compliant product. With E.U. food safety officials meting out aggressive punishment for non-compliant shrimp, the U.S. became the *"port of last resort."* These four conditions pushed record levels of relatively low-priced shrimp into the American marketplace which significantly reduced local dockside prices.[12] In 2003 imported shrimp exceeded 1.1 billion pounds (product weight) comprising roughly 88 percent of U.S. supplies, with farmed shrimp accounting for over half of total import volume. By 2004, imports reached their apex at 1.472 billion pounds (product weight).

In 2005 the domestic shrimp industry won antidumping cases against six major shrimp-exporting countries: Brazil, China, Ecuador, India, Thailand, and Vietnam for the entire shrimp category except canned or breaded market forms. As expected, there was a range in tariffs established, with some Chinese firms facing duties in excess of 100 percent. However, with shrimp imports coming from over 100 countries, circumvention

12. Record import volumes alone could contribute to lower dockside and wholesale prices. However, adding the impact of "distressed imports" (i.e., shrimp imported to the U.S. because it could not comply with E.U. food safety standards) to record import volumes and the downward pressure upon local dockside prices was even more dramatic.

occurred which muted the impact of the antidumping litigation.[13] As the tariffs took effect, huge volumes of "dusted shrimp" began arriving in U.S. ports. Importers noted that peeled shrimp, which were "dusted" with a light coating of flour, were a prerequisite to having the breading applied, and Customs and Border Protection classified dusted shrimp as breaded.[14] The historical record indicates that breaded shrimp products have always been a minor contributor to the entire shrimp category.[15] Trade association executives who represented the domestic shrimp industry argued that shrimp which were dusted were circumventing the tariffs by virtue of market form which could easily be returned to a raw, peeled product. In time, Customs and Border Protection acquiesced with the wishes of the domestic industry, but several years passed before regulations were changed to require tariffs on "dusted shrimp."

The antidumping litigation was certainly a moral victory for the domestic industry, but the hope of slowing record import volumes has proven somewhat illusory. Between 1990 and 2002 imports increased, on average, by 2.8 percent each year. Between 2003 and 2008 though, the average annual percentage increase in category imports was 15 percent.

Shrimp Fishing Then and Now

Considered alongside other North American commercial seafood resources, tropical shrimp are an anomaly because they have been one of the few, if not the only, commercial stocks that have remained healthy and have not been over-fished. Shrimp are an annual crop, with yearly abundance determined by meteorological conditions that influence ecological parameters in the coastal bays where shrimp mature before they move offshore. Due to the health of the resource, fisheries managers never considered limiting entry to the Gulf and South Atlantic shrimp fishery.

Although the resource has remained healthy, shrimp fishermen have historically been caught in a unique set of operating conditions best characterized as *"landing a high-dollar product that provided a low profit margin."* In essence, the old adage of *"too many boats chasing too little product"* typically chiseled away at producers' bottom lines and the net worth generated from shrimp fishing in all but those years where "bumper" harvests were experienced.[16] Standardized Performance Analysis (SPA) of the offshore shrimp fleet between 1986 and 1997 indicated a median value of $0.9524 necessary to land a dollar's worth of shrimp, leaving little room for the trawling enterprise to weather declines in prices received for shrimp and/or increases in prices paid for inputs (e.g. fuel, repairs and maintenance, etc.).[17]

---

13. Circumvention – in the context of international trade – refers to the practice of an exporting country affected by tariffs to ship product to a third country unaffected by tariffs in the original receiving country so that the product can be packaged or repackaged with labeling from the unaffected country. Changing the originating country thus allows the product to the shipped to the original, final destination without any duty applied by the receiving country. .

14. Since there is no Harmonized Tariff Schedule code for the market form known as "dusted" shrimp, apparently these shrimp were classified under the breaded HTS code which is1605201020 and described as SHRIMP, BREADED FROZEN.

15. Between 1990 and 2002, breaded shrimp imports averaged 2,239,988 lb. per year. Since 2003, breaded shrimp imports have averaged 70,039,591 lb. per year, an increase of 30-fold. In percentage terms, between 1990 and 2002 breaded shrimp accounted for just 0.3% of total category imports. However, between 2003 and 2008, that category contributed 5.8% to total imports.

16. Between 1965 and 2006 producers experienced several extremely favorable annual harvests when production exceeded the 42-year average by more than 30 percent (i.e., 1967 with annual production 50% above the long term average, 1981 up 42%, and 2000 up 32%). In years with above average harvests, most offshore operators sharply boosted their net worth.

17. The twelve-year time frame for the SPA included seven years below the 42-year average harvest and five years above the 36 million lb. harvest, with only two years exceeding the long-term average by 20 to 22 percent.

Between 2001 and 2005, annual production was sharply below the long-term average. Limited production coupled with relatively low prices for shrimp and increasing prices for inputs like fuel had a dramatic effect on fleet-wide effort. By the end of 2003, many vessel owners attempting to cover their vessel mortgage obligations had declared bankruptcy and exited the industry.[18] However, the exodus from the fishery did not stop in 2003. In 2006, annual, average ex-vessel prices for offshore producers were just 55 percent of what they were in 2000, but the average, annual price for diesel was $2.12. Faced with continued low dockside prices and significantly higher unit prices for fuel, fewer offshore operators remained in the industry. Today federal resource managers note that fishing effort in the 10 to 30 fathom band across the western Gulf of Mexico has declined by 80 percent when compared against effort measured in that depth zone between 2001 and 2003.

Remaining operators have seen skyrocketing increases in catch rates – considered by many as the *"Holy Grail"* for a strong, profitable offshore production sector – but the expected economic benefits of more fruitful catches have not materialized because of historically low ex-vessel prices and the steady increase in diesel prices. Even with large jumps in catch per unit of effort, remaining producers face extremely tenuous economic circumstances. The current paradigm – large catches but with razor-thin margins – has really changed the planning horizon of every operator in the fishery. Today, those who remain are literally trying to survive economically to "fish another day." This day-to-day mind set forces operators to (a) adhere to time-worn procedures – even if they are incorrect – and (b) forego any non-essential expenses. It also complicates an otherwise easy decision to invest in new production technology that promises reduced costs, and instead turns that decision into an economic *"roll of the dice"* because some production may be lost during the time it takes to tune the new trawl gear for maximum effectiveness and efficiency.[19] Such a short planning horizon is one reason why our cooperative research efforts have taken additional time to complete.

Quality Improvement Activities Conducted Under the Intensive Technical Assistance Program

Background Information

When the revenue crisis began in mid-2001, the shrimp industry began looking for ways to differentiate itself and the product it harvests from a virtual sea of shrimp imports which, to many, are considered a fungible commodity. A variety of research endeavors and industry development projects were mounted to demonstrate differences between wild, domestic shrimp and it's growing competitor: farm-raised shrimp cultured in Southeast Asia, China, and parts of Central and South America.

One of the first efforts was undertaken by Dr. Russ Miget who conducted a variety of blind, triangle taste tests using imported, farm-raised shrimp and wild, local shrimp. In virtually every instance, taste panelists could always distinguish between the two types of shrimp. Miget also queried the panelists about which shrimp they preferred. The cadre of panelists were about evenly split between those preferring the more flavorful local, wild shrimp over the more bland, farm-raised, product. While some could interpret this result as consumer indifference, it is important to realize that the wild, domestic shrimp industry can only produce about 200 million pounds of product each year, so the domestic market share – currently at about 10 percent – is determined by imports. Extrapolating the preferences of this untrained taste panel to the larger U.S. market

18. The reduction in effort was disproportionately felt across the Asian-American community which had invested in offshore trawlers, but many of these trawlers were centered in northern gulf ports and focused on harvesting white shrimp, so the reduced numbers of operators was not evenly distributed across the Gulf of Mexico.

19. In July 2008 diesel prices reached their apex at $4.02 per gallon. Using the $7,000 cost of the new trawl gear and the documented fuel savings of 28 percent, an operator would recoup the cost of the fuel-saving gear after burning 6,250 gallons of fuel; roughly the amount of fuel used over a single 15 to 20 day cruise.

suggests a demand that is several times greater than what nature can produce across the geographic range of tropical shrimp in the U.S. (North Carolina to Texas), with 90 percent of the annual harvest coming from the Gulf of Mexico!

Miget also reviewed the genesis of *"marine"* or *"briny"* flavors in wild seafoods, and found that diet immediately upon capture was the determining factor in these "marine-oriented" flavors.[20] Understanding the origins of flavor in wild shrimp, an intrinsic attribute, can serve to differentiate wild shrimp from the majority of imports which, today, are farm-raised.

Applied ITA Research Efforts Necessary to Help Producers Improve Landed Quality

The short-run objective of this ITA program track focused on the steps required to minimize deductions for substandard quality shrimp being offloaded from trawlers. If a producer follows the recommended back-deck handling and freezing steps, the best he can expect in the short run is to minimize that fraction of landed shrimp that do not meet current raw material standards. The long run objective was to help producers land a product that *"looked as good as it tasted"* while supplying a high-end, niche market capable of paying premium prices for a unique shrimp product. To move wild, domestic shrimp to the top of the price-point hierarchy in the American marketplace will take both time and a concerted, industry-wide, marketing and promotional campaign.

Early on, we faced a conundrum with the quality improvement track. The analyst can easily quantify the deleterious effect of discounts that result from substandard raw material, regardless of current market prices. However, many producers have been trapped with their memories of same-sized shrimp commanding twice the current price! To these producers, the issue is *"why bother with trying to improve landed quality ... I'm still not getting the prices I remember receiving for the same quality years ago."*

As noted in the introduction, most producers are deferring many decisions involving expenditures so they can remain liquid enough to "fish another day." This attitude impacted our outreach efforts across the quality improvement track to the point where project directors decided that the best course of action would be to conduct a variety of baseline trials that incorporated the slate of handling options, additive options, and timing for applying those additives so that future recommendations could be based on scientific verification.

Experimental work followed two pathways. Several of the trials were designed and implemented to answer nagging questions by operators. In particular, industry has always wondered about the relative effectiveness of various anti-melanosis compounds. Also, operators have wondered about the length of time the compounds remain effective once in solution; particularly Everfresh® since the unit cost of this compound is much greater than sodium metabisulfite which has been the historical preference for controlling melanosis.[21] Other trials were designed which compared the efficacy of anti-melanosis compounds applied at two different points. The first was the typical approach of introducing the additive as soon after sorting, heading, and rinsing concludes (i.e., on the back deck of the trawler). The second approach waits until the vessel returns to port before any

20. These bromophenol compounds can be synthesized, but when added to prepared feeds the essential elements responsible for the pronounced flavor of wild shrimp must volatilize because there is no flavor change in the cultured animals that consumed the amended diet. For a review of the origins of flavor in marine and aquatic foods see: Miget, R. J. and M. G. Haby. "Naturally-occurring Compounds which Create Unique Flavors in Wild-harvested Shrimp." A Wildlife & Fisheries Sciences / Agricultural Economics Staff Paper. The Texas A&M University System, College Station, Tx. 12 pp. (May, 2007).

21. Melanosis, also known as "black-spot" or "black-ring" is a photoenzymatic reaction that causes a darkening of the shell. In exaggerated circumstances, this reaction can actually discolor the outermost circumference of the muscle. Melanosis does not present any food safety concerns, but it is deemed a visual quality defect.

food additives are applied to the shrimp. Another experiment examined the various approaches for preventing dehydration of frozen shrimp aboard the vessel.

Evaluating Various Cryoprotectants for Frozen Shrimp During Extended Cruises

Background, industry experiences, and purpose of the research. Freezer burn (dehydration) can be a common defect in wild-harvested shrimp. This condition results when the on-board holding freezing unit cycles, creating a difference in temperature between the shrimp and some surface in the freezer – usually the cooling pipes or plates. Such a condition creates a difference in water vapor pressure and water migrates from the frozen shrimp (i.e., sublimates) to the pipes, which gradually become covered with frost.

As the revenue crisis continued, some producers in Texas and Louisiana questioned the necessity of adding sugar (corn syrup or corn-syrup solids) to the brine tank, citing additional cost with no visible benefit.[22] On the other hand, early proponents of adding corn syrup or corn syrup solids to brine solutions were convinced that the sugar solution created a glaze that protected the product from freezer burn (dehydration) during extended cruises. Therefore, tests were conducted to determine whether adding corn syrup or corn syrup solids to brine reduced dehydration during extended cruises.

Laboratory evaluation of cryoprotectants. Miget compared the volumes of glazes created with three treatments: (a) a saturated brine solution with no added corn syrup or corn syrup solids, (b) a saturated brine solution with corn syrup or corn syrup solids added so that the freezing and glazing process both occur in the brine tank, and (c) a two-step process where shrimp were first frozen in a saturated brine solution; then, after being solidly frozen in the brine tank, dipped in a separate container of chilled, fresh water for a few seconds. Once the shrimp were frozen using the three treatments mentioned above, same-sized shrimp tails were selected, suspended above a dish, and allowed to thaw thereby melting any glaze. Miget found virtually no difference in the volume of glazes created with the first two treatments, suggesting that adding corn syrup or corn syrup solids to the brine did not add additional glazing (protection or cryoprotection) around the shrimp tail. On the other hand, he did find that dipping solidly-frozen shrimp in chilled, potable water created an ice glaze that was approximately ten times the volume of glazes generated with the addition of corn syrup or corn syrup solids to the freezing brine, or just using salt brine alone. Although this secondary dip was an added step between freezing and placing the IQF shrimp in the frozen storage hold, it eliminated the cost of corn syrup or corn syrup solids and created a better, more consistent cryoprotectant than either conventional approach. Miget's results were independently confirmed by Tidelands Marine in Dulac, Louisiana who reported the same benefit of dipping perforated, plastic boxes filled with IQF shrimp in cold, potable water.

Thus, one of the easiest and least expensive ways to prevent dehydration on board a vessel is to apply a water glaze to shrimp immediately after removing them from the brine freezer. Laboratory tests confirmed that shrimp which are optimally frozen to 5˚F or lower will pick up a sufficient water glaze if immediately dipped in fresh water for just a few seconds.

22. In fact, a few producers do not change out their brine solution between trips due to the cost of salt and sugar. In Texas, where vessels can make three to four week trips and may freeze an average of 1,000 pounds of shrimp per day, this means 30,000 pounds of shrimp or more may be frozen in the immersion brine unit each trip. The brine is then allowed to sit at ambient temperature at the dock before being used again for subsequent trips. The bacterial loads in these systems become extremely high, and, contrary to popular waterfront belief, *spoilage bacteria* referred to as haloduric organisms not only survive salt concentrations of 25% or more, but will even slowly grow. In improperly-prepared brine (i.e., lower concentrations than the recommended 23%) an even greater number of spoilage species populate the brine solutions. While the crew is unaware of this high bacterial load, it manifests itself in greatly decreased shelf life once shrimp enter the retail chain and are thawed for display.

Using Everfresh® Instead of Sodium Metabisulfite to Prevent Melanosis

Background, industry experiences, and purpose of the research trials. Buyers continue to demand "visually perfect" wild shrimp to compete with pond-raised imports. Also, as the market share of wild-harvested shrimp drops in deference to greater pond-raised production, increasing numbers of buyers seek "chemical-free" shrimp as an additional marketing advantage. This has placed an additional burden on the industry which traditionally has relied on the use of bisulfite dips to delay melanosis. Although an alternative "processing aid" is available in the form of 4-hexylresorcinol which is marketed under the trade name Everfresh®, segments of the industry have been slow to adopt it and/or frequently use it improperly when compared to label recommendations.[23]

Improper uses of Everfresh® fall into two major categories. The first improper-use category revolves around creating solutions that are outside the range of effectiveness because additives in the make-up water – like chlorine or salt – are far beyond recommended concentrations. According to the manufacturer, Everfresh® works best as a solution made from freshwater, brackish water, or seawater. Introducing Everfresh® to highly-chlorinated water (which would be used for sanitizing food-contact surfaces) or concentrated brine solution (used to lower the freezing point of water to about -5º F or -15º C) have never been recommended. Brine solutions used to freeze shrimp should contain about 23 percent salt, roughly seven times saltier than seawater. The second type of improper uses is attempting to realize treatment effectiveness at solution temperatures far below the manufacturer's stated minimum of 35.6º F (2º C). Adding Everfresh® to brine freezing solutions simultaneously creates two improper uses of the compound (e.g., a low-temperature, concentrated brine solution). Nevertheless, some operators have routinely incorporated Everfresh® in immersion brine-freezing tanks. According to label instructions, treating shrimp with Everfresh® must be done ahead of the brine freezing process. Therefore, using Everfresh® aboard a vessel equipped with an immersion brine-freezing system requires a separate tank for introducing shrimp to the anti-melanosis solution thus adding an additional step on the back-deck.[24] Two laboratory studies were completed that used Everfresh® as an anti-melanosis chemical.

Length of time an Everfresh® solution remains effective. The first study determined the number of days Everfresh® remains effective once it is in solution. To assess the effectiveness of Everfresh® over time, separate batches of well-handled, fresh (never frozen) shrimp were treated using the same Everfresh® solution on each of five consecutive days. Each batch of shrimp was then brine frozen, stored for 30 days at -4º F (-20º C), thawed, and subsequently monitored for black-spot development while under refrigerated storage. **Results of this assessment demonstrated that the Everfresh® solution, gradually lost its potency over the five-day period. Therefore, the Everfresh® solution should be prepared anew each day, or after treating 500 to 600 pounds of shrimp.**[25]

---

23. Vessel owners have been reluctant to use Everfresh® for a variety of reasons. They feel as though sulfite dips work well, even with its inherent safety hazard to the crew, and the fact that product treated with sulfites must be labeled which effectively eliminates these shrimp from commanding a premium price for being "chemical-free." Owners continue to assert that the higher costs associated with Everfresh® keep them from using the compound. However, if shrimp are treated according to the manufacturer's recommendation (one pouch will treat 600 lb.), the additional cost amounts to less than 2¢ per pound of treated product. However, if a new Everfresh® solution must be made up each day as per the manufacturer's recommendation, and 600 pounds have not yet been treated (during slow production times of year), then the cost differential between Everfresh® and bisulfite considerably increases. While this is true, the higher production rates experienced by remaining operators throughout the year – even in the winter – sharply reduces the occurrences when daily harvests are less than 600 lb.

24. Unlike Everfresh®, sulfites are effective when added to the brine solution.

25. Fishermen used to complain that they were wasting money by using Everfresh® since they had to discard it on days production fell below 600 pounds. However, with the recent dramatic decrease in the Gulf shrimp fleet and the resulting increase in catch per unit effort, few of the vessels still operating produce less than 600 pounds of shrimp per day.

The effectiveness of Everfresh® when added to the brine freezing solution. The second study compared the effectiveness of applying Everfresh® to landed shrimp in two ways. In the first treatment, landed shrimp were introduced to the anti-melanosis compound via a dip tank prior to brine freezing (i.e., adding one pouch of Everfresh® to 25 gallons of water in a "dip" tank where the solution remains at ambient temperature – the manufacturer's recommended approach). The second treatment added Everfresh® to the laboratory brine solution at the same concentration recommended by the manufacturer, and landed shrimp were exposed to the anti-melanosis compound as they froze in the immersion brine freezing system. Shrimp exposed to Everfresh® in both treatments were stored for 30 days at -4º F (-20º C), thawed, and monitored for black-spot development under refrigeration. Black-spot developed much more rapidly on shrimp which were "simultaneously" treated with Everfresh® as they froze in the refrigerated brine than those treated in a "dip" tank of Everfresh® solution made up with fresh water at room temperature before the shrimp were brine frozen. **Study results thus confirmed the manufacturer's recommendation that Everfresh® not be added directly to the brine but mixed with ambient-temperature water and used as a two-minute dip prior to placing the shrimp in the brine tank for freezing.**

Minimizing black-spot formation in thawed shrimp requires an extra step on the back deck if Everfresh® is the preferred anti-melanosis compound. **Importantly, adding Everfresh® to the refrigerated brine – considered by some Captains and crews as a step-saver – did not produce the desired visual result.** Several characteristics of the immersion brine system, either singly or in combination, compromise the effectiveness of Everfresh® as an anti-melanosis treatment. First, at 5º F to 10º F, the solution temperature of a properly-operating, immersion brine freezer is far below the manufacturer's recommended solution temperature (i.e., -5º F compared to ambient water temperatures of somewhere between 65º F and 80º F). Second, the 23 percent salt solution is almost seven times more concentrated than the salinity of seawater which is 3.5 percent salt. Third, in a properly- operating, on-board, brine-freezing system an ice shield rapidly develops around the shrimp which may preclude the anti-melanosis compound from entering the muscle.

This study did not assess the proportional contributions of these three characteristics to the ineffectiveness of Everfresh® when added to the on-board brine-freezing system, but visual results after thawing were consistently disappointing. From an economic standpoint, it is difficult to imagine any operator incurring the cost necessary to treat 500 to 600 pounds of shrimp in a brine freezing system with Everfresh® given the historically-low dockside prices for shrimp! To meet the manufacturer's recommendation for solution concentration in a 500 gallon brine system, 20 pouches (roughly $200) would be required to treat 500 to 600 pounds of shrimp. With daily catch rates at historic highs, this approach could easily cost the firm between $200 and $1,000 per day at certain times of the year, but would yield **disappointing results**. Conversely, the manufacturer's recommended approach of dipping shrimp in a 25-gallon solution, and discarding that solution after 500 to 600 pounds of shrimp have been treated is, by far, the lowest-cost approach with the most dependable results!

Comparing Anti-melanosis Compounds Applied Across Two Time Intervals

Background and industry practices. In a large laboratory simulation of various industry procedures, Miget compared the effectiveness of two different anti-melanosis compounds: sodium metabisulfite and Everfresh® plus an untreated control against visual changes and defects created by melanosis. Sodium metabisulfite is the long-standing anti-melanosis compound which has been used to prevent progressive blackening of shrimp and other crustaceans for decades. Everfresh® is a newer anti-melanosis compound that works through a pathway different from sulfites and, as a result, cannot "overtreat" the product; one concern when using sulfiting agents. Sodium metabisulfite was applied to landed shrimp in two different ways. The first option with was to add the anti-melanosis compound to the brine tank, thereby treating the shrimp as they become frozen. This has become the most common method of applying bisulfite as the offshore shrimp fleet has converted from iced storage to on-board brine freezing. The second approach was to dip mesh bags of shrimp in a 1.25 percent sulfite solution prior to placing shrimp in the immersion, brine-freezing unit. Finally, introducing Everfresh® to landed shrimp followed manufacturers' recommendations of dipping shrimp in a solution prior to immersing the shrimp in a brine-freezing unit. These recommendations were verified by Miget with earlier trials.

Conventional wisdom suggests that preservation additives introduced as soon as possible after death will have the greatest impact because of the shortened elapsed time between death and treatment. This is certainly true when shrimp are landed and held in a refrigerated state with ice, but may not be so in the era of on-board, immersion brine freezing equipment which can solidly freeze shrimp in less than 20 minutes. Due to the potential for abuse of bisulfites aboard the trawler (i.e., sprinkling dry powder, guessing the proper concentration, etc.), some vessel owners have denied crews the use of all anti-melanosis compounds aboard the boat; instead deferring treatment with these compounds until the vessel returns to port and the shrimp can be treated in the processing plant.

Experimental design. Day-old, never-frozen, head-on, untreated, brown shrimp (*F. aztecus*) were purchased for this series of trials in August 2009. Visually, these were high-quality shrimp. Together with a mild, briny odor the raw material for this set of trials was a well-handled, top-quality harvest. One half of the shrimp were de-headed prior to treatment.

To compare the effectiveness of two time frames for introducing the anti-melanosis to landed shrimp, Miget used two distinct time frames for introducing these compounds to landed shrimp (Figure 5). In the *"back-deck treatment track,"* landed shrimp were treated prior to or during brine freezing (depending upon the compounds being used)[26], and held under frozen storage for 74 days. For the *"post-cruise treatment track"*, shrimp were frozen with an immersion, brine-freezing system, then held for seven days at -13° F (-25° C) to simulate frozen storage aboard the shrimp trawler. After the seven-day frozen storage interval, shrimp in the *"post-cruise treatment track"* were thawed, treated with the slate of anti-melanosis compounds per manufacturers' recommendations (to simulate chemical treatment in a processing plant), refrozen, and held for and additional 67 days.

26. Recall that treating shrimp with sodium metabisulfite was done in two ways. In one treatment it was introduced to the shrimp as a dip prior to immersion brine freezing and in another it was added to the brine solution and introduced as the shrimp became frozen. Everfresh® was introduced via a dip prior to immersion brine freezing; the manufacturers' recommendation for using this anti-melanosis compounds.

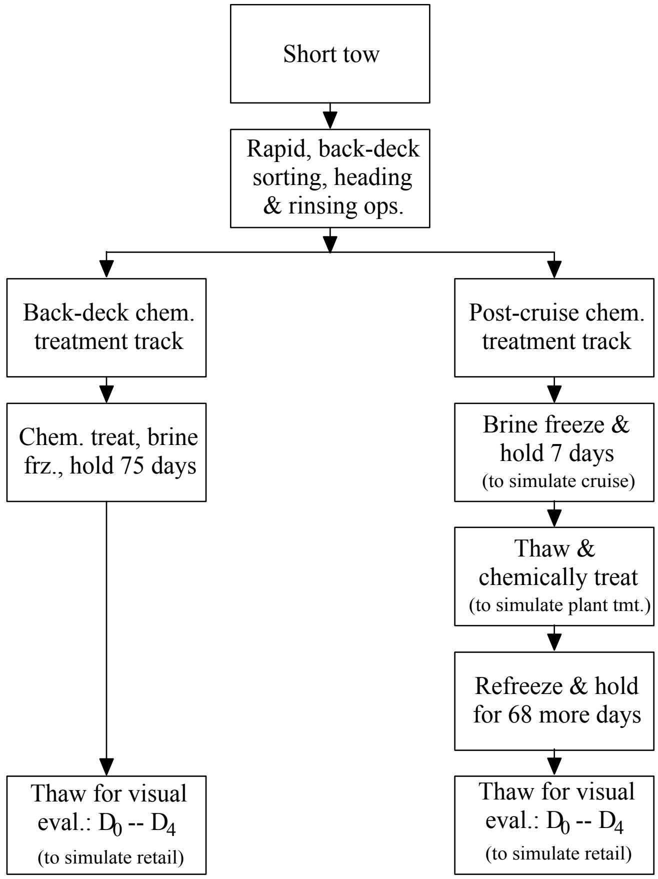


Figure 5. Experimental design for visually evaluating various anti-melanosis compounds applied to shrimp while at sea or after the cruise

On the 75th day, all eight treatments were thawed at room temperature without rinsing, and held under refrigeration (37º to 39º F or 3º to 5º C) to simulate holding by retail interests. Two shrimp from each treatment (one whole shrimp and one tail) were randomly selected, marked by clipping half of the tail fan, and repetitively photographed every other day for eight days to discern visual changes and defects. These days are designated as day_0, day_2, day_4, day_6, and day_8. This set of trials enabled the evaluation of four different post-harvest anti-melanosis treatments applied across two distinct time frames.[27] Each of four treatments was applied immediately after landing the product and the same four treatments were also applied after untreated shrimp were held in frozen storage for seven days after brine freezing to simulate completion of the cruise.

<u>Results of the various treatments on visual quality after thawing and holding.</u> Photographic documentation of visual quality resulting from each treatment for day_0, day_2, and day_4 are presented in figures 6 through 34, with captions describing the treatment, whether the treatment was applied immediately or delayed for seven days, and the number of days since thawing the shrimp to simulate retail holding. For each of the three treatments (i.e., two ways of introducing sodium metabisulfite and Everfresh® with anti-melanosis compounds, the day_4 treated shrimp are shown alongside the day_4 untreated control to show the visual difference resulting from the anti-melanosis treatment.

27. The five post-harvest treatments were (a) no chemical treatment, (b) sulfite dip prior to brine freezing, (c) sulfite treatment added to the brine, (d) and Everfresh® dip prior to brine freezing, and (e) a Prawn-100 dip prior to brine freezing.

Photographic results can be summarized across numerous classification criteria. To aid in summarizing the photos presented in Figures 6 through 34, Table 1 provides a single-page summary of how well each anti-melanosis treatment performed, and how long the visual effects of each treatment lasted once the shrimp were thawed to simulate retail handling and holding.

Table 1. A Summary of Visual Product Conditions from Day_0 through Day_4 When Whole and Headless Shrimp were Treated with Various Anti-melanosis Compounds Upon Landing and after Being Brine Frozen and Held in Frozen Storage for Seven Days

Anti-melanosis treatment	When applied	Market Form	Visual product condition on ...		
			Day_0	Day_2	Day_4
Untreated control	Back-deck (Fig. 6 – 8)	Whole	Premium	Unacceptable	Unacceptable
		Tail	Premium	Premium	Premium
	Post-cruise (Fig. 9 – 11)	Whole	Marginal	Unacceptable	Unacceptable
		Tail	Premium	Marginal	Unacceptable
Metabisulfite dip prior to brine freezing	Back-deck (Fig. 12 – 14)	Whole	Premium	Marginal	Marginal
		Tail	Premium	Premium	Premium
	Post-cruise (Fig. 16 – 18)	Whole	Premium	Marginal	Unacceptable
		Tail	Premium	Marginal	Marginal
Metabisulfite added to brine	Back-deck (Fig. 20 – 22)	Whole	Premium	Unacceptable	Unacceptable
		Tail	Premium	Marginal	Marginal
	Post-cruise (Fig. 24 – 26)	Whole	Premium	Marginal	Unacceptable
		Tail	Premium	Marginal	Unacceptable
Everfresh® dip prior to brine freezing	Back-deck (Fig. 28 – 30)	Whole	Premium	Premium	Premium
		Tail	Premium	Premium	Premium
	Post-cruise (Fig. 32 – 34)	Whole	Premium	Marginal	Marginal
		Tail	Premium	Premium	Premium

The first observation highlighted in column four of Table 1 is on the first day shrimp were thawed to mimic retail conditions (i.e., day_0). On the first day shrimp were subjected to retail conditions, visual product condition of both whole and headless shrimp was designated "Premium" – our highest visual-quality designation – across all treatments and market forms (Figures 6, 12, 16, 20, 24, 28, and 32) with one exception. **Whole shrimp from the "delayed control treatment"** was designated "Marginal" because of the darkened color of the cephalothorax (head) (Figure 9 – whole shrimp image).[28]

Over the four-day time frame while all treatments were in a refrigerated state, all shrimp tails treated with anti-melanosis compounds – either immediately upon landing, sorting and containerizing; or once the vessel returned to the dock – received a "Premium" visual quality rating. Additionally, whole shrimp treated on the back deck with Everfresh® (see Table 1, row 14 and Figures 28 – 30) remained in top visual condition during refrigerated holding across the four-day time frame. The visual quality of these whole shrimp were the exception though since only one of the eight treatments resulted in head-on shrimp keeping their top visual-quality rating over the four-day retail, refrigerated holding period.

28. For the "delayed control" treatment, brine-frozen shrimp were thawed after seven days and simply refrozen. While this treatment label may seem confusing, this is exactly what happens to shrimp which are frozen at sea during processing in order to categorize them by count size once in a processing facility.

Applying the results from Table 1 to current operating conditions in the retail food industry suggests that those operations which thaw only what will be used that day (i.e., day_0 shrimp) can use shrimp tails regardless of the anti-melanosis compounds used to treat those tails and regardless of when the anti-melanosis compounds were introduced."Premium" Whole shrimp treated with sulfites or Everfresh® either on the back deck or after the cruise received the "Premium" rating at day_0. Given the growth of the individually quick frozen (IQF) shrimp category, most retailers would deem holding IQF shrimp in a refrigerated state for four days as excessive and unnecessary. However, all shrimp tails treated with anti-melanosis compounds were deemed "Premium" across the entire four-day refrigerated time series. Back deck treatments with Everfresh® on whole shrimp resulted in those products being acceptable across four days of refrigerated storage.

This broad-scale trial began with extremely high-quality shrimp which spent a relatively short time in the net and once landed were quickly sorted from by-catch and iced. Once in the laboratory, shrimp were treated in one of two ways. *"Back-deck treated"* products were introduced to each of three anti-melanosis treatments according to manufacturers' recommendations, quickly frozen in an immersion brine system that operated at optimally low temperatures, and held at low temperatures until they were thawed. Shrimp in the *"post-cruise treatment"* category were quickly frozen in an immersion brine system that operated at optimally low temperatures, held at low temperatures to simulate frozen storage conditions aboard the trawler for seven days, then thawed and treated with the same slate of anti-melanosis compounds, then refrozen.

Study results demonstrate that when operators begin with high-quality product, any of the four anti-melanosis treatments can prevent black-spot (melanosis) which reduces visual quality within the first day a product is thawed and refrigerated. For shrimp tails, any of the four treatments – whether applied immediately or after seven days of frozen storage – resulted in products that met the highest visual quality requirements for four days while under refrigerated storage. Head-on shrimp are more susceptible to melanosis formation. However, this study revealed that any anti-melanosis compound applied immediately or after seven days in frozen storage could generate a great-looking shrimp for the day it is was thawed and held under refrigeration (i.e., day_0 shrimp). Furthermore, Everfresh® and Prawn-100® applied to whole shrimp immediately upon landing, sorting and containerizing prevented melanosis formation in this market form across four days of refrigerated storage.

This large simulation of various industry practices documented the results producers could expect from proper use of anti-melanosis compounds that prevent discoloration (darkening) of the head, the shell segments surrounding the tail, and in extreme cases the tail muscle itself. Research demonstrated that immediate treatment with anti-melanosis compounds can ensure excellent visual quality for in shrimp tails for up to four days upon thawing and holding in a refrigerated state. When sulfites are added to the brine tank and introduced to shrimp as they freeze, our visual quality indicated a bit of color change which resulted in downgrading to "Marginal" status. Even head-on shrimp, which are very susceptible to melanosis, retained excellent visual quality over the four-day refrigerated holding interval when immediately treated with Everfresh®. **However, a cautionary note is in order: any of these compounds can <u>prevent</u> discoloration in shrimp that (a) do not spend too much time in the net, (b) are handled rapidly once on deck, and (c) quickly frozen in well-operating, circulating, immersion brine freezing systems.** Importantly, no compound can undo mistakes made in trawling, back-deck handling, or freezing.

Figure 6. Back-deck Treatment: Control, brine fzn. & held 74 days, Day_0 since thawing for retail

Figure 7. Back-deck Treatment: Control, brine fzn. & held 74 days, Day_2 since thawing for retail

Figure 8. Back-deck Treatment: Control, brine fzn. & held 74 days, Day_4 since thawing for retail

Figure 9. Delayed Treatment: Control, brine fzn., held at -25º C for 7 days, thawed, not treated, refzn., held 67 days, day_0 since thawing for retail

Figure 10. Delayed Treatment: Control, brine fzn., held at -25º C for 7 days, thawed, not treated, refzn., held 67 days, day_2 since thawing for retail

Figure 11. Delayed Treatment: Control, brine fzn., held at -25º C for 7 days, thawed, not treated, refzn., held 67 days, day_4 since thawing for retail

Figure 12. Back-deck Treatment: Bisulfite dip then brine fzn. & held 74 days, Day_0 since thawing for retail

Figure 13. Back-deck Treatment: Bisulfite dip then brine fzn. & held 74 days, Day_2 since thawing for retail

Figure 14. Back-deck Treatment: Bisulfite dip then brine fzn. & held 74 days, Day_4 since thawing for retail

Figure 15. Back-deck Treatment: Control, brine fzn. & held 74 days, Day_4 since thawing for retail

Figure 16. Delayed Treatment: brine fzn., held at -25º C for 7 days, thawed & treated with bisulfite solution, refzn. held 67 days, Day_0 since thawing for retail

Figure 17. Delayed Treatment: brine fzn., held at -25º C for 7 days, thawed & treated with bisulfite solution, refzn. held 67 days, Day_2 since thawing for retail

Figure 18. Delayed Treatment: brine fzn., held at -25º C for 7 days, thawed & treated with bisulfite solution, refzn. held 67 days, Day_4 since thawing for retail

Figure 19. Delayed Treatment: Control, brine fzn., held at -25º C for 7 days, thawed, not treated, refzn., held 67 days, Day_4 since thawing for retail

Figure 20. Back-deck Treatment: Bisulfite in brine then brine fzn. & held 74 days, Day_0 since thawing for retail

Figure 21. Back-deck Treatment: Bisulfite in brine then brine fzn. & held 74 days, Day_2 since thawing for retail

Figure 22. Back-deck Treatment: Bisulfite in brine then & brine fzn. & held 74 days, Day_4 since thawing for retail

Figure 23. Back-deck Treatment: Control, brine fzn. & held 74 days, Day_4 since thawing for retail

Figure 24. Delayed Treatment: Brine fzn., held at -25º C for 7 days, thawed, bisulfite added to brine tank, refzn., held 67 days, Day_0 since thawing for retail

Figure 25. Delayed Treatment: Brine fzn., held at -25º C for 7 days, thawed, bisulfite added to brine tank, refzn., held 67 days, Day_2 since thawing for retail

Figure 26. Delayed Treatment: Brine fzn., held at -25º C for 7 days, thawed, bisulfite added to brine tank, refzn., held 67 days, Day_4 since thawing for retail

Figure 27. Delayed Treatment: Control, brine fzn., held at -25º C for 7 days, thawed, not treated, refzn., held 67 days, Day_4 since thawing for retail

Figure 28. Back-deck Treatment: Everfresh® dip, brine frozen & held 74 days, Day_0 since thawing for retail

Figure 29. Back-deck Treatment: Everfresh® dip, brine frozen & held 74 days, Day_2 since thawing for retail

Figure 30. Back-deck Treatment: Everfresh® dip, brine frozen & held 74 days, Day_4 since thawing for retail

Figure 31. Back-deck Treatment: Control, brine fzn. & held 74 days, Day_4 since thawing for retail

Figure 32. Delayed Treatment: Brine fzn., held at -25 º C for 7 days, thawed, dipped in Everfresh® solution, refzn., held for 67 days, Day_0 since thawing for retail.

Figure 33. Delayed Treatment: Brine fzn., held at -25 º C for 7 days, thawed, dipped in Everfresh® solution, refzn., held for 67 days, Day_2 since thawing for retail

Figure 34. Delayed Treatment: Brine fzn., held at -25 º C for 7 days, thawed, dipped in Everfresh® solution, refzn., held for 67 days, Day_4 since thawing for retail

Figure 35. Delayed Treatment: Control, brine fzn., held at -25º C for 7 days, thawed, not treated, refzn., held 67 days, Day_4 since thawing for retail

Table 2 presents the best-looking market forms of shrimp after they have been thawed and held under refrigeration for four days. Holding a seafood product for four days at refrigerated temperatures is quite a long holding period, so the visual appearance of these top three picks after four days is impressive.

Table 2. The Best Appearance for Day_4 Market Forms

Rank	Chem. Tmt.	When Applied	Visual Condition Score	
1st	Everfresh®	Back-deck	Whole – Premium	
			Tail – Premium	
2nd	Everfresh®	Post-cruise	Whole – Marginal	
			Tail – Premium	
3rd	Sulfite dip before brine freezing	Back-deck	Whole – Marginal	
			Tail – Premium	

Comparing the appearance of head-on shrimp after four days at refrigerated temperatures shows a slight darkening of the head for the second and third place products, but only the third place shrimp harbors any blackening. Comparing shrimp tails on the fourth day shows just a slight change in shell color to a light orange tint, but the tail fans and swimming legs are still lightly colored, with no evidence of black spot.

We believe the visual record speaks for itself in demonstrating the superiority of Everfresh® as a treatment to prevent discoloration and darkening, even when it was applied at the dock. For head-on shrimp, the photographic record clearly illustrates that darkening in the head can be minimized when shrimp are dipped in an Everfresh® solution at sea before being frozen. It will be much harder to prevent darkening and discoloration with head-on shrimp if the chemical treatment is done at the processing plant. The third place shrimp also illustrates the benefits of introducing sulfites in a dip tank.

The results of this study showed that for shrimp tails, any of three chemical treatments – whether applied immediately or after seven days of frozen storage – resulted in a product that could be displayed under retail conditions for up to four days without their shells, legs, and tail fans becoming discolored. Also, there was no black spot.

For head-on shrimp, immediate, back-deck treatment with Everfresh® resulted in the only instance where the visual appearance of head-on shrimp was judged "Premium" over the fours days of simulated retail conditions. For all other treatment chemicals, whether applied immediately or post-cruise, head-on shrimp had an acceptable visual appearance for just the first day of retail conditions. Why did the whole shrimp treated at sea with Everfresh® generate the best results over four days of simulated retail stewardship? Residual sulfite compounds can be washed away by rinsing or thawing, but Everfresh® permanently binds with the enzyme responsible for black spot so it does not rinse away and never has to be reapplied.

Everfresh is a permanent black spot treatment, so for head-on shrimp it should be the first choice among black spot-preventing chemicals.

There is a cautionary note that goes along with the images in this section. Traditionally-used chemicals tested in the laboratory did prevent blackspot, **but** these tests used shrimp which were caught in a one-hour tow during August, were culled and iced head-on within 15 minutes, and subsequently treated with various compounds in the laboratory within 2 hours. The take-away message from this broad-scale evaluation is simple. Chemical dips used to prevent blackspot on shrimp tails can be delayed until boats return to port **only if** the shrimp have not spent too much time in the net, are handled rapidly once on deck, and are completely frozen in a well-operating, circulating, immersion brine freezing system within 20 minutes. If any of these conditions cannot be met then it is recommended that all blackspot treatments be carried out on board the vessel.

Program Effectiveness Across the Quality-improvement Track

Historical Context

One Texas shrimp processor provided ITA project directors with before and after differences in the quality of shrimp he received, and the additional revenue he realized. From his information we were able to work back through the production sector and estimate the impacts that improved quality had upon vessel owners and hired captains and crews. Annually, this cooperating processor handled 4 million pounds of shrimp. Prior to fishermen using best management practices for back-deck operations, 20 percent of the shrimp delivered to this processor (800,000 lb.) had at least one major defect that downgraded it to "substandard" quality.

Once captains and crews serving on trawlers that supplied this processor adopted a science-based recipe for completing back-deck operations, the fraction of substandard shrimp they landed declined to about 14 percent (e.g., from 800,000 lb. to 560,000 lb. of sub-standard shrimp). With producers using science-based on-board handling procedures, the processor had an additional 240,000 pounds of top-quality shrimp to market. The processor received a substantially higher price for this additional 240,000 pounds, but was obliged to pay more to the fishermen who produced it. Specifically, the addition of 240,000 lb. of top-quality shrimp generated an additional $384,000 in revenue for the processor, but he paid an additional $331,200 to fishermen, thereby realizing an additional $52,800 in gross margin.[29] Improved quality created a "win-win-win" situation among hired captains and crew, vessel owners, and the processor. No additional expenses were necessary for these fishermen to generate higher earnings. Furthermore, these improvements in producer and processor revenue occurred within the current market price structure. In other words, dockside price levels did not have to increase to reap the benefits of improved quality.

Translating Research Results into Stepwise Procedures

The quality improvement track of our ITA project was reconfigured to review and, if necessary, revise recommendations that were developed when at-sea freezing was a new phenomenon in the Gulf shrimp industry. The results of the various research trials have validated the quality improvement recommendations made by project directors during the technical assistance workshops provided to TAA applicants between 2004 and 2005 (Appendix I, pp. 45-46).

These research trials also documented expected, visual results when subjecting high-quality landed shrimp (both whole shrimp and shrimp tails) to immediate and delayed anti-melanosis treatments and then thawing them after 74 days in frozen storage. For shrimp tails, four of the eight different combinations of (a) anti-melanosis compounds (which included the back-deck untreated control) and (b) two elapsed times for applying these compounds since harvest resulted in superior-looking tails over four days of refrigerated holding. Across head-on shrimp, all but the "delayed control" treatment resulted in superior-looking whole shrimp for the day those shrimp were thawed. Additionally, the immediate treatment with Everfresh® resulted in head-on shrimp receiving the top visual quality rating from day_0 to day_4.

Adding the post-freezing step of rapidly dipping hard, brine-frozen shrimp in clean, cold water prior to placing them in the frozen storage hold provided roughly ten times the volume of glazing around the IQF shrimp compared to the glaze created by adding corn syrup or corn syrup solids to the brine tank.

Fuel Conservation Efforts Conducted Under the Intensive Technical Assistance Program

The Cooperative Research Process with Shrimp Fishermen

This track of ITA efforts required project directors to undertake a number of steps to see this aspect of the ITA program work through to fruition. Steps included: (a) design of the experimental methodology; (b) creation of a protocol for collecting performance data which resulted in a data-collection booklet; (c) identification of potential, cooperating fishermen; (d) specifying and ordering the complement of experimental trawl gear and fuel-flow monitoring equipment; (e) delivering experimental gear to cooperators; (f) assisting cooperating producers with troubleshooting activities; (g) summarizing cooperative research results; and (h) conducting outreach efforts.

29. There is often significant distrust between producers and processors, regardless of the commodity. This example demonstrated that when producers improve the quality of what they deliver, they receive most of the additional revenue a processor earns as a result. This is a central tenet in the quality improvement movement, and with additional information we could highlight other examples.

Design of an Experimental Protocol

A four-step experimental protocol was designed so that cooperators could collect information about engine RPM and fuel consumption during fishing operations. In the four-step evaluation protocol, cooperators were asked to select a typical towing speed (ground speed or knot speed) for steps 1, 2, and 4 and attempt to maintain that speed across all steps that logged engine performance. Cooperators were encouraged to conduct all four steps when sea conditions were virtually "identical" so that one source of variation could be minimized among the different steps. Eight tows each lasting at least 3½ hours were required for steps 1, 2, and 4. During these three steps, each half hour each cooperator observed and recorded: (a) time of day, (b) actual knot speed (from the GPS), (c) RPM (from the tachometer), (d) fuel consumption (from the fuel-flow meter), and (e) sea conditions (**W**ith current, **A**gainst current, or **S**lack water).

Step 1 reflects the cooperating producer's baseline for engine performance and fuel consumption. In step 1, cooperators logged RPM, fuel consumption, and sea conditions when they fished with their traditional trawl gear.

In step 2 cooperators were asked to remove existing nets from their traditional trawl doors and replace them with new nets (of the same configuration and size as existing nets) made from small-diameter, braided Sapphire® webbing. Comparing results from this step with step 1 results quantifies the changes in RPM and fuel consumption that result from switching to high-tensile-strength, small-diameter, braided webbing.

Step 3 focuses on generating equivalent production with both the cooperator's traditional gear and the new experimental equipment (i.e., the combination of nets made from Sapphire® webbing that are spread with the vented, cambered trawl doors). Step 3 required the cooperator to undertake fifteen, trouble-free tows while simultaneously fishing their traditional trawl system on one side of the vessel and the experimental trawl system on the other side. For the sixteenth through thirtieth tows, the locations of the experimental and traditional gear are swapped to opposite sides of the vessel. Swapping the gear halfway through step 3 is done to control for side-of-vessel production bias. The objective of this step is to reach production parity between traditional and experimental gear. This is a keystone step in the experimental protocol because cooperators would not agree to pull a more fuel-efficient trawl if production suffered. The large number of tows was suggested so that minor adjustments could be made in the experimental gear so that it produced equivalently with the cooperator's traditional trawl. Additionally, thirty tows facilitates statistical analysis using the power of large numbers. This step did not require half-hour logging of fuel consumption or RPM data because the vessel was simultaneously fishing with two types of gear; each with different levels of resistence.[30]

Once the cooperator was satisfied that the new gear could produce equivalently to his traditional rig, step 4 required that he fish the experimental gear on both sides and log knot speed, engine RPM, fuel consumption, and sea condition data. With this last step completed, project directors could compare RPM and fuel use among the producer's traditional trawl (Step 1), new nets made from Sapphire® webbing when opened with the cooperator's traditional trawl doors (Step 2), and new nets opened with cambered, vented trawl doors (Step 4).

Creation of the Data Collection Booklet

Developing the data collection booklet was an important task since a completed booklet was the only scientific record of the comparative analysis we would receive. Project directors designed the data collection booklet which cooperating producers could use to record the requested information every thirty minutes while fishing (Appendix II, pp. 48-52). Both English and Spanish versions were generated. The booklet contained

30. Although step 3 did not measure fuel use, cooperating producers consistently noted that during this step, the vessel typically pulled toward the side with the traditional gear since resistance was greater on that side.

important reminder instructions along with various contact information. Booklet covers and those pages which separated each step were laminated while the pages which required the captain to complete were printed on waterproof paper. Some cooperators opted to record their data directly into a spreadsheet file.

Identifying Potential Cooperators, Ordering, and Delivering Experimental Equipment

Project directors attempted to spread the cooperative research efforts across various ports in Alabama, Louisiana, Mississippi, and Texas. For the most part project directors were successful in identifying producers interested in evaluating currently-used equipment and the experimental trawl gear while fishing. In choosing cooperators, directors also wanted to ensure that the testing was spread across the ethnicities found among the production sector, and with the original cadre of cooperating producers project directors identified, this objective was met. Project directors also contacted fishermen who had evaluated various environmental gear over the years. In this aspect of the project, the cooperator was the driving force in complete success or utter failure as far as adoption of the gear in particular ports was concerned.

After discussing the project with potential cooperators and getting their commitment, the doors, webbing, sleds (or dummy doors) and fuel-flow meters were ordered. Enough gear was ordered for each cooperator to outfit the vessel completely, even though the full complement would only be used in the fourth step. Each element in the complement of equipment was custom-tailored to each specific cooperator. For instance, there are several sizes of the vented, cambered doors available for shrimp trawlers. Selecting the proper size of the experimental gear required project directors and the distributor to make the conversion for potential cooperators. The first rule of thumb was to select a cambered door that represented roughly half of the area of the traditional flat door the cooperator historically used.

The size and configuration of nets also influenced the decision about replacement door size.[31] Braided Sapphire® webbing is available in different diameters, and discussions with the cooperator helped project directors select the diameter of Sapphire® with tensile strength similar to the webbing currently in use. Depending upon when cooperators initiated the cooperative research project determined the type of sled they received. Some cooperators received sleds with the integrated buoyancy tank while others received sleds manufactured from flat bar. Fuel-flow metering equipment is specifically designed for the main engine (both type and horsepower). Project directors had to be precise when specifying and ordering this experimental component because it was difficult to return and incorrect model to the manufacturer and would consume valuable testing time while another device was shipped.

The complement of experimental gear was personally delivered to each producer. While a time consuming part of the project, this gave project directors the chance to interact with cooperating fishermen and help them understand the protocol they were asked to follow.

31. Cambered doors should be roughly ½ as long as current trawl doors, but net size, style, and webbing material also influence door size. For example, a 45 ft. nylon net requires 1.4m^2 doors but that same net made from Spectra® or Sapphire® can be spread with 1.1m^2 doors. Evaluation by elite fishermen suggest the following rules of thumb. If the producer currently pulls 4 – 40 ft. to 45 ft. nets, then 1.1m^2 doors should be used. If a producer pulls 4 – 45 ft. to 50 ft. nets, then 1.4m^2 doors should be selected. Sea trials of doors required to spread 4 – 50 ft. to 55 ft. nets are preliminary and suggest that 1.4m^2 doors are marginal at the 2nd tow point. Sea trials of doors required to spread 4 – 55 ft. to 60 ft. nets have not yet taken place. In summary, the size of door should be selected that allows nets to spread fully when the doors are pulled from the front-most towing point (which creates the smallest angle of attack). The smaller the angle of attack, the less resistance created which reduces the RPM necessary to maintain towing speed. Cost differences between door sizes (i.e., between 1.1m^2 and 1.4m^2 or between 1.4m^2 and 1.6m^2) are about $200 per set (or $50 per door) and is a minor issue. When in doubt, the next larger door size should be selected.

Troubleshooting Activities

We were fortunate to have two early-adopting fishermen available as consultants to other cooperating producers who were experiencing trouble rigging the cambered doors since only a two-point bridle was used. Recall from footnote 9 (page 5) that traditional, flat doors require a four-point bridling system to establish (a) the angle of attack and (b) the "posture" or cant of the large face of the door to the seabed (i.e., the angle between the large towing-side face of the door and the sea bed). Virtually all of the consulting time was spent helping cooperators understand the rigging differences between their traditional doors and the experimental ones during step 3, the production parity step. This was the largest hurdle cooperating producers faced in moving through the four-step experimental protocol since the bridling system was foreign and even some elite cooperators were perplexed when trying to tune the doors so that (a) the new gear efficiently fished (i.e., determined after each tow by examining the condition of the shoes of the doors for shine, mud accumulation at the toe or heel of the door, etc.) and (b) the new gear produced on par with the traditional equipment.

Captain Louis Stephenson, owner-operator of the F/V Master Brandon, made trips to Tarpon Springs, Fl. (twice); Port Isabel, Tx.; Houma, La.; Bayou LaBatre, Al.; and Pascagoula, Ms. to assist cooperating fishermen having trouble tuning the new gear so it produced equally with the cooperators' traditional gear. In every case where Captain Stephenson's expertise was requested by a cooperating fishermen, he generally spent two or three days offshore with the cooperator helping them tune the experimental gear until production equaled that obtained from the traditional equipment. Captain Stephenson has also conducted several training sessions in Port Isabel, Tx and various locations in North Carolina, and Mississippi with ITA investigators. Captain Manuel Calderón made one trip to the Rio Grande Valley to work with two fleets that quickly invested in the new trawl gear. We made more extensive use of Stephenson's expertise because he has a much more flexible schedule as an owner/operator than Calderón since his schedule is primarily set by Western Seafood, his employer.

Issues That Impacted Cooperative Research With Elite Producers

Historically various experimental gear work with fishermen has occurred in the off-season (e.g., late fall, sometimes during relatively mild winters, and early spring). However, with all producers adopting a very pragmatic attitude about only fishing when expected abundance is high, we lost a large fraction of the off-season window typically used to evaluate new equipment. With the winter window all but closed, we had to find cooperators who were willing to evaluate the gear during peak production periods, but our list of potential cooperators dwindled because many were concerned about losing production and thus revenue during this time frame. This happened several times and forced project directors to locate substitute cooperators. Since the gear was specific to the original cooperator, some time was lost in locating a replacement cooperator, rerouting doors, webbing, and in some cases fuel-flow monitors.

Project directors were mindful of the expense required for this broad scale evaluation, and attempted to offer every chance for cooperators to be successful with this new gear. Directors were also mindful about the importance of the performance data being generated since that was the only scientific record from these trials. This precipitated four emphatic requests of cooperators.

- First, steps 1, 2, and 4 should be conducted when sea conditions are identical, or very similar! To get an accurate comparison of fuel use and RPM when fishing different diameter webbing and different doors at different times, as much variation as possible needed to be eliminated in sea conditions.

- Second, establish one towing speed like 2.8 to 3.0 knots and try to keep it constant throughout the study. This study compared the RPM and fuel required to push the vessel along at a pre-determined towing speed <u>in knots</u> when fishing with (a) traditional doors and existing webbing (Step 1), (b) nets made from Sapphire® webbing spread with traditional doors (Step 2), and (c) the experimental gear. (Step 4).

- Third, during trawling operations some change in towing speed, RPM, and fuel use is normal, so project directors asked cooperators to record actual values from the GPS (providing ground speed), the tachometer (RPM), and fuel-flow meter (gallons per hour). If towing speed is normally 2.7 knots, over the course of a 3½ hour tow it is reasonable to expect speeds from 2.6 to 2.8 knots.

- Fourth, every set of half-hour readings brings this project closer to measuring the benefits the new steel doors and nets made from Sapphire® webbing have on fuel savings across the shrimp industry. These readings are the only scientific information upon which we have to base estimates so directors implored cooperating fishermen to be accurate and complete with their data-logging activities.

Despite our requests, and the echos from our expert, consulting fishermen, some cooperators misunderstood basic requirements. There were two common problems. The first was holding RPM constant across steps 1, 2, and 4 as opposed to ground speed. Trying to work backwards with RPM as the independent variable is akin to using crop yield to predict rainfall. The second problem was producers not recording exact, observed values for variables like ground speed, but instead just writing their pre-selected speed for every half-hour observation. This preempted any analysis of variance.

Though some cooperators misunderstood our requests and produced data that were of limited value from a scientific standpoint, the anecdotal impressions of the gear and the individual making the claims had a huge impact upon adoption. The best example of adoption of this breakthrough fuel-saving technology has occurred in the Rio Grande Valley; historically the home of the largest offshore shrimp fleet in the world. From a scientific standpoint, only two of three cooperators documented fuel savings. However, the top fleet manager in the combined ports of Brownsville/Port Isabel had a vessel chosen to evaluate the new gear (e.g., drawn from a pool of interested fishermen), and because of this manager's support for the project and the results (which were also verified by pre- and post-trip fuel-tank soundings) Brownsville/Port Isabel has seen a wholesale changeover to the new gear. However, the reverse is also true. A premature decision to abandon the project by one respected manager in another Texas port slammed the door on any other producer even trying the gear, and until late Fall 2009, not a single vessel in Palacios was pulling the new fuel-saving gear.[32]

Results from the Cooperative Research Process

Cooperative research with elite producers was more akin to a series of case studies than a replicated evaluation primarily because no two cooperating shrimp fishermen had the same complement of characteristics which included (a) vessel horsepower, (b) vessel length, (c) net size and type, and similar operating environments. Importantly through these differences in vessel, nets, and areas fished were the real strengths of this work because the same gear was tested aboard differently-powered vessels, pulling different nets, across different water depths and bottom terrains. The cooperative research efforts demonstrated that the vented, cambered doors and the braided, Sapphire® webbing did, in fact, result in production parity while doing so with less fuel than the original gear pulled by the cadre of cooperators. Results generated by elite cooperators across the Gulf of Mexico suggest that other operators can expect somewhere between a 20 and 29 percent reduction in fuel use with the experimental fishing gear (i.e., somewhere between the 25th and 75th percentile values) (Figure 36).

32. Beginning in October 2009, one fishermen in Palacios has moved from being a hired Captain to an owner/operator, and has converted to the new gear which was funded by the Sustainable Fisheries Partnership; one example of the third-party initiatives discussed in a subsequent section.

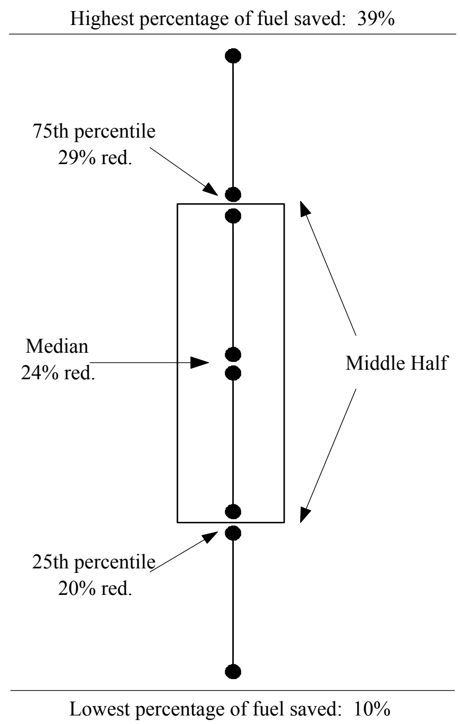


Figure 36. Fuel savings realized by elite cooperators when using experimental gear expressed as percentile values

Outreach Efforts to Support the Fuel-saving Trawl Gear Track

Outreach efforts were a key element in this ITA track, and took numerous forms – from informal dockside meetings with fishermen to called workshops and formal symposia – with varied audiences that included producers (e.g., owner-operators, fleet owners, hired captains and crews), Sea Grant personnel, state regulatory officials, and a variety of environmental non-governmental organizations (NGOs). The chronology of our outreach efforts are summarized in Table 3. The outreach efforts were substantial, and selected events are detailed in chronological order following the table. Every event organized by project directors or Captain Louis Stephenson provided attendees with a variety of reference materials that summarized our cooperative research efforts to date.

Table 3. Outreach Events Conducted about the Fuel-saving Trawl Gear

Event[a]	Location(s)	Date
Informal Dockside Meetings	Tarpon Springs, Fl. Brownsville, Tx. Houma, La. Bayou LaBatre, Al. Pascagoula, Ms	01/2007 – 08/2008
Meeting with La. Dept. Of Wildlife & Fisheries	Baton Rouge, La.	04/2007
Trawl Gear Symposium – Gulf States Marine Fisheries Comm.	Galveston, Tx	03/2008
North Carolina Trawl Gear Workshop Series	Supply, Snead's Ferry, Morehead City, Bayboro, Swan Quarter, Wanchese	04/2008
Trawl Gear Workshops	Venice and Empire, La.	04/2008
Meeting with Ms. Dept. of Marine Resources	Biloxi, Ms.	07/2008
Sustainable Fisheries Partnership	Brownsville, Tx.	08/2008
Brownsville/Port Isabel Shrimp Producers Assn.	Brownsville, Tx.	08/2008

Event[a]	Location(s)	Date
Sustainable Fisheries Partnership	New Orleans, La.	09/2008
Sea Grant Researchers' Conference	College Station, Tx.	09/2008
Gulf & South Atlantic Fisheries Foundation	Tampa, Fl.	11/2008
Sustainable Fisheries Partnership	Houston, Tx.	11/2008
Ocean Conservancy	Freeport, Tx.	02/2009
Expert Working Group	Houston, Tx.	03/2009
Louisiana Sea Grant / LSU Ag. Center Trawl Gear Workshop	Intracoastal City, La.	04/2009
Southeastern Fisheries Association	Key West, Fl.	08/2009
Popular press: Seafood Business and National Fisherman		2009

a. Outreach events that are discussed following the table are shown in italics.

<u>Informal dockside meetings.</u> As the new gear was being distributed across the Gulf states, project directors and Captain Louis Stephenson conducted dockside workshops to explain the gear to cooperators and other producers interested in the new trawl doors. In addition, Captain Stephenson independently conducted meetings with producer groups in Tarpon Springs, Fl.; Brownsville/Port Isabel, Tx.; Houma, La.; Bayou LaBatre, Al.; and Pascagoula, Ms.

<u>Meetings with Louisiana Dept. Wildlife & Fisheries.</u> Commercial fishermen face numerous state and federal regulations that govern seasonal openings, net sizes, minimum mesh sizes, required environmental gear, maximum trawl door dimensions, etc. In Louisiana, state law specified a maximum height was specified for trawl doors. Unfortunately, this value was exceeded by the new cambered doors which are half as long, but a few inches higher that traditional doors. After his favorable experiences with the cambered doors in Terrebonne Parish, Captain David Chauvin approached the Louisiana Department of Wildlife and Fisheries about the possibility of a regulation change that would permit the use of the new trawl doors.[33] Captain Chauvin prompted a special meeting between the Louisiana Department of Wildlife and Fisheries and Gary Graham in early April 2007. With fishermen and lawmakers by his side, the ideas presented in Graham's invited presentation became Senate Bill 20 which cleared the way for a regulation change (via a new state law) that increased the allowable height requirement thus clearing the way for widespread adoption of the new cambered, vented, fuel-efficient doors in Louisiana waters.

<u>Trawl Gear Symposium – Gulf States Marine Fisheries Commission (GSMFC).</u> Project directors hosted a Trawl Gear Symposium and field trip at the March, 2008 meeting of the GSMFC in Galveston for regional Sea Grant fisheries staff as well as a variety of environmental non-governmental organizations (NGOs). This proved to be one of the most important outreach sessions conducted under this track of the ITA project because it introduced the concept of *"environmentally-friendly"* fishing gear to various environmental NGOs. These NGOs would go on to undertake varied "third-party initiatives" to support changeover to more fuel-efficient gear used in the shrimp trawl fishery. These initiatives are detailed under the sub-heading "Third Party Initiatives" that begin on page 40.

33. Captain Chauvin is a shining example of the benefits of cooperative research with elite producers. He completed the four-step experimental procedure, documenting a 27% reduction in fuel when the vented, cambered doors were used in place of his traditional doors. He has become an advocate for this technology and has spread the word about the results he documented among his peers. Captain Chauvin helped troubleshoot connection problems that have prevented the gear from producing equally to traditional equipment. His willingness has resulted in many producers in the *Bayou Country* making the switch to vented, cambered doors. When project directors encountered him in March 2008, Chauvin had procured another set (4) of the vented, cambered trawl doors for his second vessel. Directors also learned that about forty shrimp fishermen in the Houma/Chauvin region have opted for the cambered doors which allowed them to remain on the water despite record fuel prices in 2008.

North Carolina Fuel-efficient Trawl Gear Workshop Series. One of the attendees at the March, 2008 GSMFC in Galveston was Bob Hines, the North Carolina Sea Grant fisheries specialist. During our symposium, Bob asked about the idea of our conducting a series of workshops along the North Carolina coast to debut the new trawl gear to local shrimp producers. Ultimately, Bob organized five educational programs between April 21–25, 2008 in Supply, Snead's Ferry, Morehead City, Bayboro, and Swan Quarter, with a sixth workshop organized "on the fly" by project directors in Wanchese; the largest offshore fish port in North Carolina. Four individuals attended from Texas including Gary Graham, Mike Haby, Captain Louis Stephenson, and Patrick Riley – the General Manager of Western Seafood in Freeport and one of the pioneers who made the cambered doors work in the offshore shrimp fishery.[34] Some 80 fishermen and fleet owners attended, and interest in the new fuel-efficient gear was quite high.[35] Each workshop began with a 50-minute PowerPoint® presentation (Appendix III, pp. 54-68) with questions throughout, followed by a hands-on demonstration of the doors and how to bridle them by Captain Louis Stephenson, Gary Graham, and Patrick Riley. Workshop participants received a hand-out of the PowerPoint presentation and a DVD of underwater footage showing the performance of the vented, cambered doors taken in 2007 off Panama City, Florida that summer. Each workshop began around 5 p.m. with a presentation which was followed by the demonstrations which took place outside.

A formal evaluation was conducted after the workshop series ended via a mail survey (see Appendix IV, pp. 70-72). Answers to questions in the first section suggest that participants really increased their understanding of the new doors, but still needed more information about how to size the new doors so net spreading would equal what they were getting with traditional trawl doors (Table 4).

Table 4. Question 1 series: "Please check the box for each statement that best describes your impressions of this workshop."

I understand ...	Agree or Strongly Agree	Mean (Range 1-4)
the fuel savings other fishermen have experienced with this new trawl gear.	91%	3.45
how to connect the new doors to my towing bridles and nets so they will produce equally to the gear I normally use.	100%	3.30
how to troubleshoot improper connections between towing bridles, doors, and nets.	100%	3.30
how to determine the size of cambered doors needed to replace my wooden or aluminum doors.	78%	3

April was one of the busiest times of the year for this audience. Even though the workshops corresponded with the beginning of the Spring shrimp harvest, participants concurred that the workshop they attended was useful, informative, and important to them (Table 4). Attendance alone suggests that a high value was placed on participating because the discretionary time of these fishermen is so valuable in April. In some cases the Captain asked crew members to attend on their behalf. These individuals noted on the evaluation that the decision to switch to the new gear was not their decision. This reduced both the "agreement" percentages and the mean scores in the third and fourth questions in Table 5.

34. Getting a sample of the new cambered trawl doors to North Carolina to demonstrate the connections was deemed essential. Less-than-truckload round trip freight to haul a set of doors was about $1,000. At that point Patrick Riley volunteered to drive the doors over for the fee quoted by the low-bid common carrier. Patrick was a real asset to the workshop series, and his cooperative spirit made the logistics much easier since he was part of the presentation panel.

35. Importantly, the North Carolina shrimp industry is dominated by inshore operators who typically use less fuel. Smaller hulls with less powerful engines will extend the length of time necessary to pay for the doors with reduced fuel expense compared with a typical offshore Texas operator who can recoup the $7,000 cost of the doors alone with a two-to-three week trip.

Table 5. Question 2 series: "Please check the box for the statement that best describes your thoughts about this workshop."

	Agree or Strongly Agree	Mean (Range 1-4)
Attending this trawl door and webbing workshop was important to me.	100%	3.36
The speakers and the demonstrations were informative.	100%	3.64
The information about these new doors and the braided Sapphire® webbing was practical to my operation.	90%	3.00
I can use what I learned in my operation.	90%	3.10
Overall, this was a very educational workshop.	100%	3.50

When asked whether they would review handout materials and watch the underwater DVD of trawl performance, all respondents said "Yes" (Table 6). When pressed about whether they would change to the new cambered doors, 78 percent said "Yes".

Table 6. Question 3 series: "What will you do with the information you received at the workshop you attended?"

	Percent (Yes)
I have (or will) review the handout material provided at the meeting.	100%
I have (or will) watch the DVD of how the fuel-saving gear performed.	100%
I will consider changing to the new cambered doors and Sapphire® webbing.	78%

The fourth series of questions asked respondents' about their impressions of the workshop experience. Fishermen appeared quite pleased with the workshop and demonstration. The results show that the presentation, though highly ranked by participants, was really just a warm-up for the demonstrations. In essence, fishermen wanted to get their hands on the new doors (Table 7).

Table 7. Question 4 series: "Please rate the quality of this workshop & demonstration."

	Good or Excellent	Mean (Range 1-4)
Slide presentation.	91%	3.18
Discussion & demonstration about properly sizing and rigging the new doors.	100%	3.18
Handout materials (copy of presentation & DVD).	100%	3.55

The final segment of the survey sought information about participants' operating conditions, and whether they had applied for Trade Adjustment Assistance in 2004 or 2005 (Table 8). Summarizing annual fuel consumption results provides little information since the audience was comprised of both inshore and offshore producers. As expected, the reported size of trawl doors currently in use demonstrated wide variation owing to the area fished. The average annual tenure as a commercial fishermen was high at 38 years in the business, and reflects the larger trend that few young people, not already connected to fishing, are choosing that line of work. Half of all respondents did apply for Trade Adjustment Assistance. Most, however, noted that they did not receive any benefits.

Table 8. Workshop Evaluation – Classification Questions.

	Mean
How many gallons of fuel do you burn each year aboard your vessel(s)?	12,300
What size are the trawl doors you now use?	Varies
How many years have you commercially fished?	38
Did you apply for Trade Adjustment Assistance in 2004 or 2005?	50% Yes

Our workshop reviewed results from other offshore operators in the Gulf of Mexico as well as two from the South Atlantic. Therefore, our results focused on the performance of doors larger than most inshore fishermen in North Carolina would use. One important outcome of our conducting the workshop series was interest among producers which precipitated North Carolina Sea to organize a cooperative research effort with inshore fishermen to explore the vented, cambered doors in the inshore shrimp fishery using other funding sources.

Meeting with Mississippi Dept. of Marine Resources. After hearing about the North Carolina workshop series held in April 2008, biologists from the Mississippi Department of Marine Resources volunteered to organize a workshop similar to the one held in Baton Rouge the year before for Mississippi shrimp fishermen in late May just before their shrimp season gets underway. Gary Graham and Louis Stephenson conducted that workshop. Forty sets of reference materials (hand-outs and DVDs) were taken to the program, but attendance was approximately 120 producers. One key outcome from that meeting organized by the Department of Marine Resources was clearing another regulatory hurdle, thus allowing shrimp fishermen to use the vented, cambered doors in Mississippi waters. That new regulation took effect September 22, 2008.

Ocean Conservancy videography about new trawl gear and by-catch reduction devices. In February 2009 Graham and Haby worked with Ocean Conservancy video staff and Western Seafood to highlight the new trawl gear and by-catch reduction devices required in the gulf shrimp fishery. This video clip was posted to the Ocean Conservancy's website and was shown continuously during the International Boston Seafood Show held in March 2009. The Ocean Conservancy also posted the identical video clip to "YouTube."[36]

Expert Working Group (EWG) meeting. In March 2009, project directors called a meeting of elite shrimp fishermen who participated in the cooperative research process to discuss the content, design, and distribution of reference materials for the larger industry. Elite producers came from Alabama, Louisiana, and Texas. This cadre of producers represented nearshore and deep-water operators, fishermen who worked in soft bottom in the western Gulf and those who fished the hard, sandy bottom off Florida's West coast during the winter for pink shrimp. The group was skewed towards the owner/operator with just one fleet owner in attendance.

This was an excellent two-day meeting, and the group addressed every question project directors asked. The EWG noted that with the wholesale changeover to the cambered doors and nets constructed from Sapphire® webbing in Brownsville / Port Isabel, they believed the reference materials did not need to be translated into Spanish. On the other hand, with no Vietnamese-American fishermen currently using the gear, the group thought that the additional expense of translating the reference materials in Vietnamese was warranted.[37]

One unanimous conclusion from the EWG was their willingness to appear on camera to review their experiences with the new gear, explain the results they generated, and outline any additional troubleshooting required in their particular circumstances. This would have been a powerful message for other producers who may vacillate about the decision to convert. The EWG also talked about additional research they would like to see that would quantify a variety of conditions that had not been subjected to testing such as fuel use at different towing points (which would create different angles of attack), minimum knot speed required to keep the doors canted perpendicular to the sea bed, the impact of clip-on flotation on fuel economy, etc.

Louisiana Sea Grant / LSU Ag. Center trawl gear workshop. Graham and Haby traveled to Louisiana during April 2009 and met with offshore shrimp fishermen in, Dulac, Galliano, Golden Meadow, Intracoastal City, and Morgan City. Previously developed reference materials were updated with more recent unit prices for

---

36. The clip is located at [http://www.oceanconservancy.org/site/PageServer?pagename=ftf_retailers_roundtable] and also on YouTube at [http://www.youtube.com/watch?v=E-2V1qe7pnY].

37. In the original complement of cooperating fishermen project directors identified one Asian fishermen in Palacios who expressed real interest in the new gear since he operated a large, twin-screw vessel that consumed over 30 gallons per hour. Ultimately, this cooperator fell victim to the *"roll of the dice"* condition outlined on page 9, and reneged on his commitment. Unfortunately, this operator was on track to test the largest cambered trawl doors offered to shrimp fishermen since his vessel pulled four 55 ft. – 60 ft. nets; the largest used in the offshore shrimp fishery.

diesel fuel and distributed to producers throughout the week, and during the organized meeting in Intracoastal City; a large fish port with virtually all Asian-American operators. The presentation to roughly 40 operators was translated into Vietnamese by Ms. Thu Bui, Fisheries Agent with Louisiana Sea Grant and the LSU Ag. Center. These producers were extremely interested in the new gear because they use large vessels that consume about 30 gallons per hour.

During this meeting, project directors also discussed opportunities to conduct fuel-saving gear trials among the Vietnamese fishermen in Louisiana. The State of Louisiana is making funds available to help producers convert to less resistive fishing gear. Project directors were asked to comment about their experiences with the approach used in this ITA effort. Assuming funds were available to do so, one of the issues that surfaced was using a very small cadre of elite producers, having production information available so compensation could be made for production shortfalls during the third step of the four-step experimental protocol. We also outlined some of the problems we had with our cooperative research efforts, though our Louisiana cooperator, David Chauvin, provided some of the best information compiled in our ITA gear research effort.

<u>Southeastern Fisheries Association annual meeting.</u> Gary Graham was an invited speaker at this regional association meeting in Key West during August 2009. His primary presentation topic was the experiences and results from the cadre of elite producers who participated in the cooperative trawl door research.

<u>Popular Press Articles.</u> Graham was interviewed for two articles that featured the fuel-saving gear; one in *Seafood Business*[38] (June 2009), and the other in *National Fisherman* (November 2009) (see Appendix V, pp. 74-79).

Impacts Generated from the Fuel-saving Trawl Gear Track

Estimated Fuel Saving for Offshore Shrimp Trawlers in Brownsville/Port Isabel

From the information collected through a Standardized Performance Analysis (SPA) of offshore shrimp trawlers between 1986 and 1997, three percentile values for annual fuel use were computed.[39] These are reflected as the 25th percentile (58,775 gal.), the 50th percentile (66,101 gal.), and the 75th percentile (73,485 gal.). Table 8 (below) integrates (a) baseline fuel-use information between 1986 and 1997 collected as part of the SPA project, (b) documented fuel savings reported by an elite, Brownsville fisherman who participated in the cooperative research funded by USDA/CSREES, and (c) two levels of gear adoption by the Brownsville / Port Isabel fleet. Biennial fuel consumption was reduced from the Baseline values to reflect savings that resulted from local experiences with the new cambered, vented trawl doors. These documented fuel-use savings rates ranged from 28 to 39 percent during experimentation with the new trawl gear between November and December 2007. Taking the more conservative value of a 28 percent reduction and using the 50th percentile in biennial, baseline fuel consumption of 132,202 gal., the individual trawler would save about 37,017 gallons when using the new vented, cambered trawl doors (Table 9, Column 2). Using the computed, average, biennial unit cost of $2.478 per gallon (i.e., an average price of $3.173 per gallon for calendar 2008, and an average price of $1.783 per gallon for January – August, 2009) a trawler which used the median quantity of fuel would have reduced fuel expenditures by almost $92,000 (Table 9, Column 3).[40]

---

38. See [http://www.seafoodbusiness.com/archives.asp?ItemID=4056&pcid=267&cid=268&archive=yes] for the article.

39. The reference for this work is Haby, M.G., L.L. Falconer, and J.L. Parker. "Developing an Economic Profile of Texas Shrimp Trawling Operations in The Gulf of Mexico." *in* Johnstone Richard and Ann L. Shriver, compilers. <u>*Proceedings of the Tenth Biennial Conference of the International Institute of Fisheries Economics and Trade, July, 2000.*</u> Corvallis, Oregon. pp. 1-6 (August, 2001).

40. The source for industrial No. 2 diesel prices can be found at [http://tonto.eia.doe.gov/dnav/pet/hist/d220300002M.htm]

Table 9. Biennial (2008-2009) Brownsville / Port Isabel Baseline Fuel Consumption and Reductions from Baseline Use Values by 28 and 39 Percent Which Were Documented by a Cooperating, Local Fisherman When Trawling with the Vented, Cambered Doors and Sapphire® Webbing

	Per-Vessel		Converted Vessels (132)		Entire, Local Fleet (165)	
	Gal. Used	Fuel Cost	Gal. Used	Fuel Cost	Gal. Used	Fuel Cost
Baseline[a]						
25th percentile (58,775 gal.):	117,550	$291,289	15,516,600	$38,450,135	19,395,750	$48,062,669
50th percentile (66,101 gal.):	132,202	$327,597	17,450,664	$43,242,745	21,813,330	$54,053,432
75th percentile (73,485 gal.):	146,970	$364,192	19,400,040	$48,073,299	24,250,050	$60,091,624
28 percent reduction:						
25th percentile (42,318 gal.):	84,636	$209,728	11,171,952	$27,684,097	13,964,940	$34,605,121
50th percentile (47,593 gal.):	95,185	$235,871	12,564,420	$31,134,633	15,705,525	$38,918,291
75th percentile (52,909 gal.):	105,818	$262,217	13,967,976	$34,612,645	17,459,970	$43,265,806
39 percent reduction:						
25th percentile (38,853 gal.):	71,706	$177,687	9,465,192	$23,454,746	11,831,490	$29,318,432
50th percentile (40,322 gal.):	80,643	$199,836	10,644,876	$26,378,003	13,306,095	$32,972,503
75th percentile (44,826 gal.):	89,652	$222,158	11,834,064	$29,324,811	14,792,580	$36,656,013

a. Baseline fuel use was documented from a Standardized Performance Analysis of the Texas offshore shrimp industry between 1986 and 1997.

Bracketing the savings from baseline consumption to the middle fifty percent of the overall distribution in annual diesel use, a producer at the 25th percentile would reduce his 2008–2009 fuel use by roughly 32,914 gallons (saving roughly $81,561 in fuel expense). A fisherman who experienced baseline fuel use at the 75th percentile level would see a 41,152 gallon reduction with the new vented, cambered doors and nets made from Sapphire webbing®. Over 2008 and 2009, dollar savings at the 75th percentile fuel use level would have been valued at just under $102,000.

During winter and early spring of 2008, Cameron County shrimp vessel owners made a "wholesale" change to the new fuel-efficient gear, with roughly 80 percent of the fleet (132 vessels) switching from their traditional flat, wooden doors and nylon nets to the vented, cambered doors and nets made from Sapphire® webbing. With an 80 percent conversion rate, the fleet-wide savings in fuel and fuel expense when the median use value is assumed would be 4.88 million gallons valued at approximately $12.1 million for the two-year period (Table 9, Column 4). Considering the middle fifty percent of the distribution in historic fuel use, the new gear has saved Cameron County shrimp fishermen between 4.3 and 5.4 million gallons valued between $10.8 million (25th percentile in historic fuel use) and $13.5 million (75th percentile in historic fuel use) (Table 9, Column 5). Comparing such a high level of savings with the cost of the new doors – about $7,000 per vessel – producers who made the switch had "broken even" after burning several thousand gallons of fuel; about the duration of one fourteen-day cruise.

The adoption of this equipment has occurred along a pathway very familiar to veteran Extension faculty; specifically, once industry "leaders" understand the significance of the results and make a commitment to change, others quickly follow suit.

Other Benefits Accruing from Vented, Cambered Trawl Doors

The experimental protocol presented on page 29 above suggests that fuel conservation was the primary objective of evaluating the vented, cambered doors which spread nets made from small-diameter, braided webbing. Fuel conservation and the reduction in fuel expense is, unequivocally, the largest saving attributable to the new gear. However, there are other maintenance considerations that are favorably impacted by using less resistive trawl gear.

Reducing the frequency of oil and filter changes. With less resistive gear, lower RPM directly translates into fewer service hours accumulating on the engine clock for each sixty minutes the engine runs. For example, a Caterpillar® 3412 operating at 1,800 RPM generates one service hour for every clock hour operated at that speed. If RPM is reduced to 1,400 and operated for one hour, then 0.78 hr. (just over 45 minutes) would be added to the engine clock. The frequency of oil and filter changes – still the cheapest engine inputs – are governed by engine hours. By reducing RPM by 22 percent, the required interval for oil changes grows to 514 hours of operation vs. 400 hours; a 28.5 percent increase in the interval between oil and filter changes. Changing oil and filters for a Caterpillar® 3412 currently costs about $350. For every 4,000 hours the engine operates at 1,800 RPM, ten oil and filter changes would be required; yet, were the engine running at 1,400 RPM only eight oil and filter changes would be necessary within the same 4,000 hours saving the owner $700.

<u>Top-end engine overhauls.</u> Caterpillar® recommends a top-end engine overhaul after 254,000 gallons of fuel are used. Computing the time interval between top-end overhauls can be done by knowing the annual gallons burned. From the SPA data, the median vessel used 66,101 gallons per year. This suggests that a top-end overhaul would be required every 4 years (264,000 gal. ÷ 66,101 gal./yr.) On the other hand with the new cambered doors and nets made from Sapphire® webbing, the vessel would burn 47,593 gallons per year (a 28 percent reduction in fuel consumption documented in Brownsville, Tx between December 2007 and January 2008) thus requiring a top-end overhaul every 5.5 years. At a cost of about $8,500, and assuming no increase in the cost over a sixteen-year interval, the owner would have spent $34,000 while using the traditional trawl gear and $17,000 had he switched to the fuel-saving gear. Thus, extending the interval by 1.5 years (37.5 percent) generates a 50 percent savings in the top end overhaul over the sixteen year assumed life of the engine.

<u>Major engine overhauls.</u> In addition to the top-end overhaul after every 254,000 gallons of fuel, Caterpillar® recommends a major engine overhaul after every 528,000 gallons are used. The approximate cost for this scheduled maintenance is $20,000. Using the same annual fuel use comparison as in the top-end overhaul example above, producers using their traditional gear would require a major engine overhaul about every eight years (528,000 gal. ÷ 66,101 gal./yr.). With reduced fuel use, owners who converted to the new gear would need a major overhaul every eleven years. After the same sixteen-year interval, scheduled major overhaul maintenance for the vessel towing the traditional gear would be $40,000 while the producer who converted to the new, fuel-saving gear would incur half that expense.

In summary, the new hydrodynamic trawl doors drive a variety of costs out of the enterprise by requiring fewer RPM to move the vessel forward during trawling operations which reduces fuel consumption. Fewer RPM reduces the service hours logged per clock hour of service. This extends the interval between oil and filter changes. Using less fuel also extends the interval between top-end and major engine overhauls which are governed by the amount of fuel consumed.

Third Party Initiatives

Our objective with this track of the ITA program was straightforward: to reduce operating expenditures for offshore shrimp trawlers. However, as word spread about the success of this breakthrough trawl gear, other organizations expressed interest in helping to move the gear changeover process further along. This work has blossomed into an effort with several facets which may help remaining operators overcome the economic crisis. These include (a) making credit available to producers who want to switch to the new gear and (b) using environmental protection and sustainability as verified, credence attributes associated with wild-harvested shrimp as a way to target domestic shrimp toward *"high-end"* users who are willing to pay a premium for seafoods harvested in an environmentally-friendly manner. The third parties and their activities are outlined below.

Shrimp Fishery Financing Activities Underwritten by the Sustainable Fisheries Partnership

The first called meeting of the Sustainable Fisheries Partnership (SFP) occurred in Brownsville during August 2008. The SFP is a roundtable of NGOs interested in providing incentives for sustainable, environmentally-friendly seafood-production practices. This called meeting was the first time the SFP had expressed any interest in working with the Gulf shrimp industry, and was a direct result of representatives attending the Trawl Gear symposium and field trip offered during the March 2008 Galveston meeting of the Gulf States Marine Fisheries Commission. At the Brownsville meeting, SFP representatives discussed the idea of providing low-cost financing to producers interested in switching from their traditional trawl gear to the cambered doors and Sapphire® webbing. Ultimately the Gulf of Mexico Shrimp Fishery Improvement Roundtable – a part of the larger Sustainable Fisheries Partnership – has developed a plan to offer the entire complement of fuel-saving trawl gear and a fuel-flow meter to producers at half price (See Appendix VI, p. 81).[41] This is an important, first-of-its-kind opportunity for remaining producers since (a) most credit extended to the shrimp industry vanished with the advent of the revenue crisis and (b) converting to the fuel-saving gear requires roughly $17,000 per vessel.

At the second called meeting in Houston just before Thanksgiving, 2008, SFP leadership also expressed interest in moving forward with another financing opportunity, but this program would have a much greater cap that would allow that subset of producers who have been compliant with all environmental requirements access to significant pools of capital for much-needed deferred maintenance such as engine overhauls or new engines, hull and wheel (propeller) maintenance or upgrades. etc. Just as in the previous example, credit is a godsend to this industry since most producers have, out of necessity, been deferring maintenance for several annual cycles. At some point these deferrals must be addressed, else the vessel could be sidelined.

Texas Parks and Wildlife

The Coastal Fisheries Division of Texas Parks and Wildlife began promoting the new cambered trawl doors and nets made from Sapphire® webbing in Spring 2008 to Texas commercial shrimp fishery licenseholders (see Appendix VII, pp. 83).

Support for Fuel-conserving Trawl Gear in Louisiana

The catastrophic damage and loss of life from Hurricane Katrina, galvanized many segments of the Louisiana economy into pro-active advocates for restoration and development. Huge sums await those segments that have prepared well-designed plans. The seafood industry is a case in point. Currently the Louisiana shrimp industry is designing a huge cooperative research effort to examine the benefits of the fuel-saving trawl gear which will include subsidized purchases of the gear, and a more aggressive system of compensating cooperators for losses during the start-up phase of their experimentation. This commitment is a direct offshoot of ITA involvement in that state's shrimp production sector that began with Graham (a) selecting David Chauvin as a cooperating captain to evaluate the vented, cambered doors and (b) helping the Louisiana Department of Wildlife and Fisheries rewrite their trawl door regulations to accommodate the vented, cambered doors. Graham fields several calls a week from program leadership about how best to pursue this large-scale cooperative research effort.

In addition, Mr. Robert Nguyen who works with LGL, Inc. – one of the few regional, private environmental consulting firms working with the shrimp industry – recently reported that there are two very good Asian-American fishermen in Venice, La. who are asking numerous questions about acquiring the doors. These producers were exposed to them in 2008 when Graham conducted a by-catch reduction workshop in Venice and also discussed the impact the cambered doors were having on fuel conservation.

---

41. The first applicant for the"half-price" offer by the Gulf of Mexico Shrimp Fishery Improvement Roundtable to execute a trawl-gear switchover is in the port of Palacios. Another applicant is in the Northern Gulf and has been comparing the fuel used by one of our elite cadre of cooperators and the vessels in their fleet. The Gulf of Mexico Shrimp Fishery Improvement Roundtable program covers 50 percent of the total cost.

Eco-labeling Initiatives by the SFP

Financing for the new gear and other vessel-related needs definitely peaked the interest of producers, many of whom have been internally funding critical refurbishment projects. However, SFP and the Marine Stewardship Council (MSC) are also in the process of conducting a preliminary assessment of the Gulf shrimp fishery to determine if it can meet the certification criteria for a sustainable, environmentally-friendly fishery. This preliminary assessment is being funded entirely by the SFP. MSC certification is considered the *"gold standard"* to firms interested in handling only sustainably-harvested seafoods produced in the most environmentally-mindful manner possible. The MSC certified the Alaskan salmon fishery several years ago, and has re-certified it within the last year. Documented fuel savings from the experimental fishing gear as well as virtual unanimous compliance with current state and federal regulations requiring a variety of environmental gear in shrimp trawls have made the relationship with the SFP and MSC possible.

Eco-marketing Initiatives

CleanFish® is an organization dedicated to supplying niches for seafoods produced in the most environmentally-friendly and sustainable ways possible. This marketing organization attended our trawl gear symposium during the March 2008 Gulf States Marine Fisheries Commission meeting, subsequently expressed interest in working with selected producers to market their products. The clients of CleanFish® are those firms who cater to customers with high expectations of environmental protection being factored into food production strategies. Beginning in September 2009, CleanFish® began working with selected, local shrimp producers to market wild, gulf shrimp harvested with the fuel-saving trawl gear to West Coast retail and food service establishments who handle sustainably-harvested seafoods. The shrimp prices quoted by CleanFish® have been much higher than those offered by the larger category market. This marketing breakthrough suggests that remaining operators may finally begin to grow their profit margins receiving with the combination of higher dockside prices and historically-high catch rates.

Program Effectiveness Across the Fuel-conservation Track

This track of the ITA program has documented wholesale change to fuel-saving trawl gear in what was once the largest offshore shrimp port in the world: Brownsville / Port Isabel. The fuel-saving trawl gear track has generated dramatic savings while producing the same volume of shrimp as would have been harvested with fishermen's traditional gear. For producers, reduced fuel use immediately helps grow the margin between historically low ex-vessel prices and increasing unit prices for inputs.

When expressed in terms of dollars saved by the Cameron County fleet as a result of total ITA investment of roughly $200,000, project directors estimate that **for every ITA dollar invested, Cameron County shrimp producers <u>alone</u> realized a saving in diesel expense somewhere between $53.83 ($25^{th}$ percentile value in fuel use under a 28 percent saving) and $67.30 ($75^{th}$ percentile value in fuel use under a 28 percent saving)**. This ratio does not include the savings generated from cooperating fishermen located in other ports or states, nor does it include cost savings from other groups of fishermen outside of Cameron County which would sharply boost the direct benefits of USDA investment in the Gulf and South Atlantic shrimp industry through the Texas ITA program. The Texas ITA program, overseen by faculty jointly appointed to the Texas AgriLife Extension Service and the Sea Grant College Program at Texas A&M University, can take credit for fuel savings currently being generated in the shrimp trawl fishery.

Reduced fuel consumption has also opened several doors for the Gulf shrimp industry, primarily through a variety of third-party initiatives including (a) financing opportunities offered by the Sustainable Fisheries Partnership for compliant producers (i.e., those producers who use the mandated environmental gear in their nets such as turtle excluder devices and by-catch reduction devices), (b) the establishment of *"high-end,"* niche markets for sustainably-produced shrimp through Clean Fish®, and (c) undertaking an assessment to determine whether the Gulf shrimp fishery can meet the Marine Stewardship Council certification; a worldrecognized eco-labeling program. These initiatives are underway, but more time will be required before those efforts fully bloom.

Summary

Intensive Technical Assistance efforts undertaken for the Gulf and South Atlantic shrimp industry by faculty jointly appointed with the Texas AgriLife Extension Service and the Sea Grant College Program at Texas A&M University focused on both sides of producer profitability.

On the revenue side, project directors conducted a variety of applied research to document the results producers could expect from proper use of anti-melanosis compounds that prevent discoloration (darkening) of the head, the shell segments surrounding the tail, and in extreme cases the tail muscle itself. Importantly, these compounds can prevent discoloration in shrimp that (a) do not spend too much time in the trawl, (b) are handled rapidly once on deck, and (c) quickly frozen in well-operating immersion brine freezing systems. No compound can undo mistakes made in trawling, back-deck handling, or freezing. Research demonstrated that proper use of anti-melanosis compounds can ensure excellent visual quality for in shrimp tails for up to four days upon thawing and holding in a refrigerated state. Even head-on shrimp immediately treated at sea with Everfresh® retained excellent visual quality over the same four-day interval.

Driving avoidable costs out of the production enterprise is a high priority for project directors since shrimp prices plummeted in late 2001. In fact, with such high unemployment in many regions of the country, shrimp prices throughout 2009 have been among the lowest in most operators' memories. Achieving production parity between traditional and experimental trawl gear while doing so with reduced fuel consumption has been a significant reward for the industry. Unlike marketing efforts which require key ingredients of time and effort by the industry to affect a change in the price point of domestic shrimp, reducing fuel consumption is an individual decision that is relatively easy to achieve. Most Cameron County shrimp fishermen have adopted the new experimental trawl gear, and have collectively saved between 4.3 and 5.4 million gallons valued between $10.8 million and $13.5 million for the 2008 – 2009 biennial period.

Interestingly, reduced fuel consumption also impacts sustainability issues which were unheard of a decade ago such as *"a reduced carbon footprint"* which immediately makes shrimp harvested by fishermen pulling the new gear more attractive in that segment of the marketplace where environmental issues are an important product attribute. In Fall 2009, the first sales of shrimp produced with a reduced carbon footprint demonstrated a higher price per pound than the shrimp category average.

Appendix I – The Marks of Quality (a handout prepared for technical assistance workshops)

The *Marks of Quality* Necessary to Produce Premium-Quality, Wild, Domestic Shrimp

Mark 1. **Try to reduce tow times.** Recommendations from work with Texas brown shrimp suggest:

Months	Number of Drags or Drag Time
January - April	3 drags per night
May - June	No drags longer than 3 hours
July - September	No drags longer than 2 hours
October - December	No drags longer than 3 hours

Mark 2. **Continually process portions of the catch.** As shrimp are sorted on the back deck, follow the ***"One-basket Rule"***. Once a basket is filled with heads-on or headless shrimp, start processing that basket of shrimp – rinse them, dip them in a sulfite or Everfresh® solution, then ice them or brine freeze them.

Mark 3. **Use proper shrimp dip treatments to prevent blackspot.** It is best to apply a 1.25% shrimp dip (sodium bisulfite or sodium metabisulfite) for a one minute soak time with mild agitation. **A 1.25% dip equals 1 pound (1½ cups) of powder per 10 gallons of clean water.** The mix water should be air temperature. Cold or ice-water dips are less effective. Soak times longer than one minute are not necessary and may add excessive sulfites. After 500 lb. have been treated, discard the solution and mix a new batch. Also, be very careful when handling and storing sulfite powders. If these powders get wet they release toxic sulfur dioxide fumes.

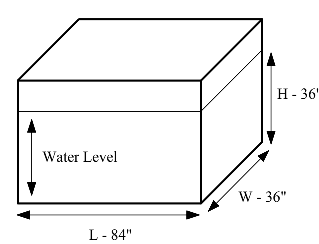
Everfresh® can be used in place of sulfite dips, but it must be applied sooner after harvest and the dip water should not contain any chlorine. Chlorinated water reduces the effect of the Everfresh® treatment. Use one 200 gram pouch of Everfresh® per 25 gallons of clean, chlorine-free water. This mixture is the same as 3½ ounces of Everfresh® per 10 gallons. Soak the shrimp for 2 to 3 minutes before draining, icing, or freezing. After 500 lb. have been treated, discard the solution and mix a new batch.

Mark 4. **Ice shrimp as soon as possible.** On ice boats the processed shrimp should be stored in layers of ice that do not crush or damage the shrimp. Boxes that hold and protect the shrimp during iced storage prevent crushing and improve shrimp quality. Proper and immediate use of ice makes a big difference in the shelf-life of the shrimp. Mix three parts ice to one part shrimp. Remember that temperature determines the length of acceptable shelf-life of shrimp.

Product Temperature	Resulting Shelf Life
68º F (20º C)	1 day
50º F (10º C)	4 days
32º F (0º C)	13 days

Mark 5. **Know the gallon capacity of your brine tank.** The capacity of the tank determines how much salt, dip powder and corn syrup should be added. Mark the "fill line" (height) and measure it in inches. Then measure the inside width and length of the tank in inches.

Gallon capacity = (**H**eight x **L**ength x **W**idth) ÷ 231
So… (36" x 84" x 36") ÷ 231 = 471 gallons



Mark 6. **Correctly charge the brine system "before" each trip.** Fill the tank with clean (city) water to the "fill line" you marked, **then** add the ingredients shown in the following table. Dissolve all ingredients **before** starting the compressor.

Ingredients	Proportions	Quantity for 471 gallons
Food-grade salt	2.53 lb. per gal.	(2.53 x 471 gal.) = 1,192 lb.
Dip powder (if not pre-treated)	0.074 lb. per gal.	(0.074 x 471 gal.) = 34.8 lb.
Corn syrup or Corn syrup solids (CSS)	0.12 gal. per gal. 1.19 lb. per gal.	(0.12 x 471 gal.) = 56.5 gal. of corn syrup (1.19 x 471 gal.) = 560 lb. of corn syrup solids

Adding 2.53 pounds of salt per gallon of water results in a 23.3% brine concentration that can be refrigerated to -6˚F. **Not adding enough salt will result in a warmer brine temperature that will prolong the time required to freeze shrimp.** Monitor the brine temperature with a thermometer that reads below freezing (32˚ F or 0˚ C). The best operating temperature is less than 5˚F (-15˚C). Corn syrup or CSS creates a glaze on the shrimp that reduces freezer burn (as well as lost weight) and ensures a smooth shell.

A refractometer can be used to assure the salt concentration is right. A few drops of water from the brine tank should be placed on the instrument and allowed to warm for about 1 minute for an accurate reading. A reading of near 23% indicates a proper mix of salt (and dip if it is used in the brine). When the recommended amount of corn syrup or CSS is added, the refractometer will read between 28% and 30%.

Mark 7. **Don't overload the brine tank with shrimp.** Follow the ***"15 to 100 Rule"*** – never load more than 15 pounds of shrimp per 100 gallons of brine. Putting too much shrimp in the brine tank at one time results in a slow or incomplete freeze that can damage shrimp quality. In the 471 gallon tank example, only 70 lb. should be placed in the tank at one time. Make sure the brine temperature remains below 5˚F. Use small onion bags (about 30 lb. capacity) or rectangular 4-inch deep shrimp boxes (about 20 lb. capacity) that minimize the distance to the center of the container so that *all the shrimp* freeze in 20 minutes.

An agitator or submersible pump circulates cold brine and reduces the time necessary to freeze shrimp. Freezing shrimp as quickly as possible reduces weight loss, salt uptake and drip loss upon thawing.

Mark 8. **Monitor the *"20-minute Rule."*** If the correct amount of salt has been added, and if the refrigeration system is working properly, and if the tank is not overloaded with shrimp, the operating temperature of the brine should remain less than 5˚F (-15˚C) and all shrimp should freeze within 20 minutes. Longer freezing times will add salt to the shrimp and pull water (and weight) out of the shrimp.

Mark 9. **Recharge the brine system during each trip**. The concentration of salt and dip powder will gradually decrease as more and more pounds of shrimp are frozen. Therefore, salt must be added to maintain the correct concentration for proper freezing. **Two methods can be used to recharge the brine tank**.

A. The *Pounds* Method. Add *28 pounds of salt* after freezing every 1,000 pounds of shrimp (28 pounds is approximately 6.5 inches of salt in a 5 gallon bucket). Dissolve the 28 lb. of salt in a small amount of warm water before adding to the cold brine tank. If dip is used in the brine freezer, *1 cup (8 oz.) of powder* should be added after freezing 1,000 pounds of shrimp**. Corn syrup or CSS do not have to be recharged during the trip.**

B. The *Refractometer* Method. Recharge with salt when the refractometer drops *two percentage units* from the original reading (for example from 30% to 28%). To recharge, add 2% salt. With a 471 gallon brine tank, the amount of salt to add is figured by multiplying the gallon capacity of the brine tank (471 gal.) by the weight of one gallon of salt brine (8.3 lb.) by the two percentage units (0.02). So (471gal. x 8.3 lb./gal. of brine x 0.02) = 78 pounds of salt to add. Seventy-eight pounds of salt fills a 5 gallon pail about 18 inches. If you are using sulfites, add three cups of that along with the seventy-eight pounds of salt. Mix and recheck reading.

Prepared by R.J. Miget and M.G. Haby. 2005. Excerpted from R.J. Miget and M.G. Haby. "Maximizing Revenues by Producing Top-quality Shrimp for the U.S. Market." in *Wild-harvested Shrimp Technical Assistance Curriculum*. pp 47-64.

Appendix II – Example Pages from the Four-step Data Collection Booklet

Comparing Fuel Consumption and Shrimp Production Using Traditional Trawl Gear and Experimental Equipment

Data Collection Tables for a Cooperative Study with Elite Fishermen

This cooperative research & extension effort is funded by USDA through the Intensive Technical Assistance Program

AgriLIFE EXTENSION
Texas A&M System

Sea Grant

Step 1. Establishes your baseline fuel consumption with the trawl gear you normally use (nylon or Spectra® webbing and wooden or aluminum doors) when pulled at your normal trawling knot speed.

Important Reminders:

1. Please use the same trawling speed for each tow.
2. Stabilizer deployment should be same for all tows; either in or out.
3. Please record information every 30 minutes for each of 7 tows that last at least 3½ hours.

Engine Make & Model: ______________________________ Horsepower: ______________________

Location of your try net (please check one): ________ Port ________ Starboard Door dimensions: ____________________

Nets (Size & Material): ____

Tow	Elapsed Time	Date	Time of Day	Knot Speed	RPM	Gallons per Hour	With / Against Current	Notes / Comments
1	½ hr.							
1	1 hr.							
1	1½ hrs.							
1	2 hrs.							
1	2½ hrs.							
1	3 hrs.							
1	3½ hrs.							

Step 2. Measures the proportional effect Sapphire® webbing used with your traditional trawl doors has on fuel consumption when pulled at your normal trawling speed in knots (the same knot speed used in step 1).

Important Reminders:

1. Use the same trawling speed **in knots** as in Step 1.

2. Stabilizer deployment should be same for all tows; either in or out.

3. Please record information every 30 minutes for each of 7 tows that last at least 3½ hours.

Tow	Elapsed Time	Date	Time of Day	Knot Speed	RPM	Gallons per Hour	With / Against Current	Notes / Comments
1	½ hr.							
1	1 hr.							
1	1½ hrs.							
1	2 hrs.							
1	2½ hrs.							
1	3 hrs.							
1	3½ hrs.							

Step 3. This step requires that you tune the experimental gear, then compare shrimp production generated when you pull your traditional gear on one side and the experimental equipment on the other, then swap sides and repeat the test to address side bias (a common approach used in evaluating shrimp loss with BRDs).

Important reminders:

1. Please use the same trawling speed **in knots** as you have in previous steps.

2. Shrimp production from four-rig trawls should be recorded from just the outside nets.

3. Shrimp production from two-rig trawls should be recorded along with try net production.

4. Good tows are those that are free of mudding, net/TED twists, tickler-chain fouling, torn gear/shark bites in bag, etc. If any such problems occur, then please do not do not record any results for that tow.

5. 30 good tows are required to compare production. 15 tows are required with the experimental gear on the port side and another 15 tows are required with the experimental gear on the starboard side.

				Traditional Gear		Experimental Gear		Try Net	
Tow	Date	Time In	Time Out	Side (P/S)	Production	Side (P/S)	Production	Production	Notes / Comments
1									
2									
3									
4									
5									
6									
7									

Step 4. Measures fuel consumption with the experimental doors and Sapphire® webbing when pulled at your normal trawling speed in knots

Important reminders:

1. For a meaningful comparison, use the same trawling speed **in knots** as you did in all previous steps.

2. Stabilizer deployment should be same for all tows; either in or out.

3. Please record information every 30 minutes for each of 7 tows that last at least 3½ hours.

Tow	Elapsed Time	Date	Time of Day	Knot Speed	RPM	Gallons per Hour	With / Against Current	Notes / Comments
1	½ hr.							
1	1 hr.							
1	1½ hrs.							
1	2 hrs.							
1	2½ hrs.							
1	3 hrs.							
1	3½ hrs.							

Appendix III – An Example of the PowerPoint® Presentation for Producer Meetings

Reducing Fuel Consumption in The Gulf & South Atlantic Shrimp Fishery

A presentation hand-out from the fuel-efficient, cambered trawl door workshop.

Sponsored & Hosted by

Thu Bui – Fisheries Extension Agent
LSU Ag. Center & Louisiana Sea Grant Program

Prepared by

Gary Graham[1], Mike Haby[1], Patrick Riley[2] & Louis Stephenson[3]

1. Texas AgriLife Extension Service / Sea Grant College Program / Texas A&M University
2. General Manager of Western Seafood, Freeport, Texas
3. Owner-Operator FV Master Brandon, Hitchcock, Texas

Funded by (i) USDA/CSREES through the Intensive Technical Assistance Program, an outcome of participating in Trade Adjustment Assistance in 2004 and 2005 and (ii) the State Energy Conservation Office headquartered within the Texas Comptroller of Public Accounts

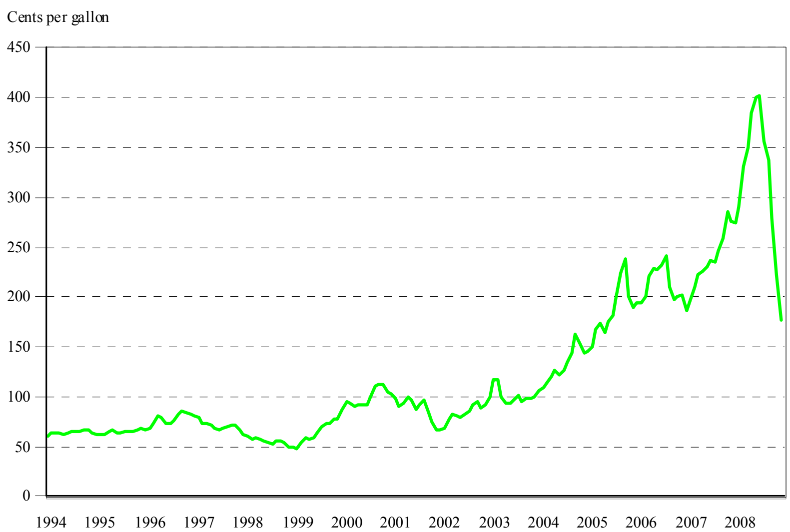
AgriLIFE EXTENSION Texas A&M System — Sea Grant

Fuel: Today the Largest Production Expense for Wild-harvested Shrimp

- **Based on TAMU Standardized Performance Analysis of offshore Texas shrimp trawlers between 1986 and 1997, the median vessel used 66,101 gallons of diesel each year.**
  - **In 1997 the cost for those 66,101 gallons was $49,576 ($0.75/gal).**
  - **By 2006, the cost for that same quantity was $144,596 ($2.19/gal).**
  - **Last year 66,101 gallons cost fishermen $209,765 ($3.17/gal).**
- **In 2006 roughly 40 percent of the 2,666 permitted offshore trawlers remained idle because of historically-high fuel prices & low dockside shrimp prices.**
- **In 2007, <u>days fished</u> across the Gulf in the 10 to 30 fathom range had declined by 78 percent when compared with the 2001-2003 base.**

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Nominal U.S. Industrial Price for No. 2 Diesel by All Sellers: 1994 – 2008



Source: http://tonto.eia.doe.gov/dnav/pet/hist/d220300002M.htm

AgriLIFE EXTENSION
Texas A&M System

Sea Grant

Pioneers who found *"a better way"*

Counterclockwise from left: Patrick Riley and Captain Manuel Calderón – Western Seafood Co., Captain Louis Stephenson – F/V Master Brandon, Gary Graham – Sea Grant College Program

AgriLIFE EXTENSION
Texas A&M System

Sea Grant

Traditional Trawl Doors and the Cambered, Steel Doors

AgriLIFE EXTENSION
Texas A&M System

Sea Grant

Double-rigged, Energy-conserving Trawl System being Retrieved & Loaded

AgriLIFE EXTENSION
Texas A&M System

Sea Grant

Work Began in April 2005 at Western Seafood in Freeport, Texas

- FV Isabel Maier – Captain Manuel Calderón
  - Cat 3412
  - Nozzle with Skewed Rice Wheel
  - 4 – 47.5 ft. Two-seam Trawls
  - Spectra® Netting
  - Wooden doors 9 ft. x 40 in. (2.79 m^2) [9 ft. x (40 in. ÷ 12 in./ft.) x (1m^2 ÷ 10.76 $ft.^2$)]
  - Burning 18.5 – 19 gph while towing @ 3 kt. (1525 – 1550) rpm

- Initial results
  - Experienced difficulty in setting
  - Doors laid in outward position
  - After nights of adjustment, got gear to bottom & spreading
  - Sled sank faster than trawl doors
  - Adjusted leg lines
  - No 4-point chain bridles – 2-point chain bridles

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Positive Results from Initial Trials

- Initially evaluated 2.1 m^2 doors. These seemed too big. Settled on:
  - 1.4 m^2 cambered doors
  - Compared to the area of the 108 in. x 40 in. traditional flat door (2.79 m^2), the 1.4 m^2 cambered door is 50% smaller.
  - 330 to 616 lb. with weight added.

- RPM were reduced from 1,525 to 1,400 (8%) while maintaining a 3 kt. towing speed.

- Cambered doors generated tremendous spreading power.

- Lead line and tickler 4 to 6 inches off bottom resulted in a 19% shrimp loss so the bottom of the doors were modified with a "flat" shoe.

- Added fuel flow monitoring system.

- Modified sled (dummy door) to slow descent to sea floor.

AgriLIFE EXTENSION Texas A&M System — Sea Grant

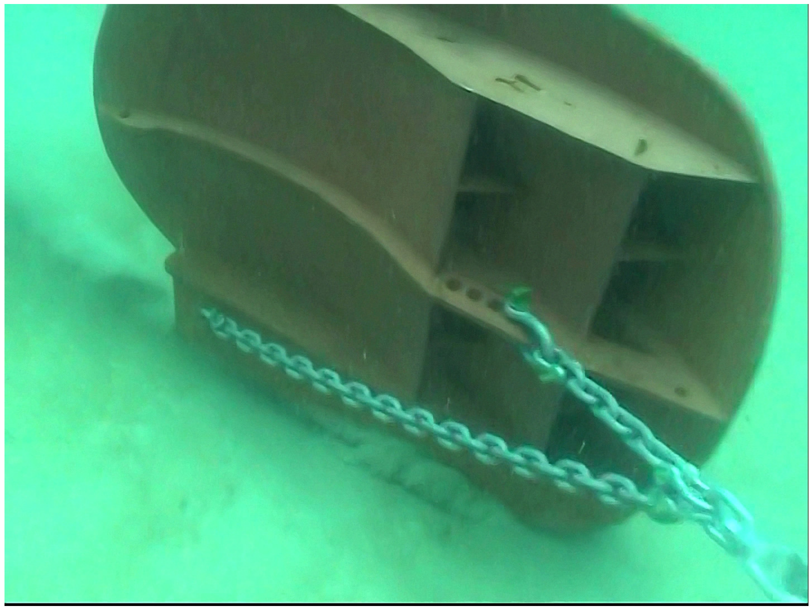
Cambered Doors with “Factory” Shoes

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Cambered Doors with “Flat” Shoes Added

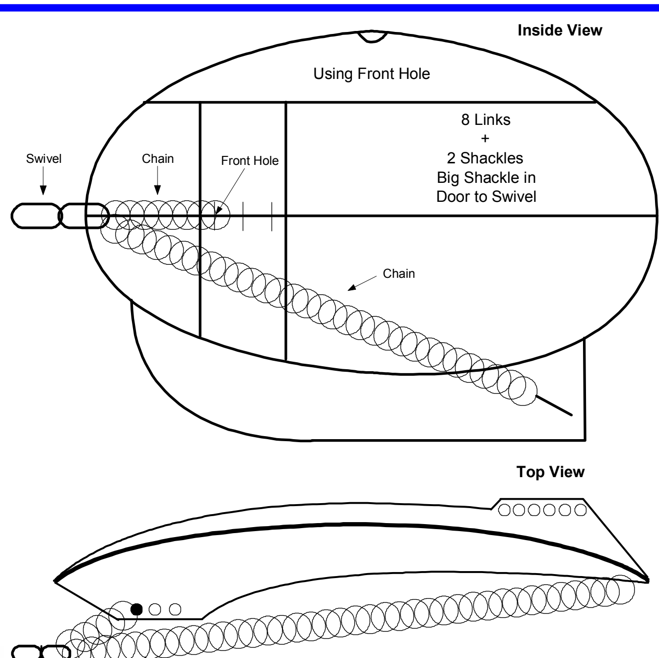
AgriLIFE EXTENSION Texas A&M System — Sea Grant

Chain Bridle Connected to a 1.1m^2 Door



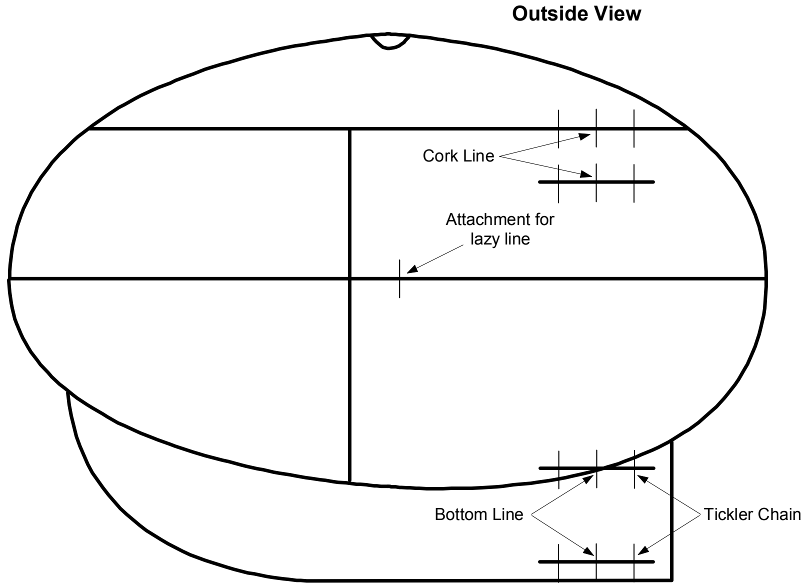
AgriLIFE EXTENSION Texas A&M System
Sea Grant

Bridle Configuration for 1.4m^2 Door (1)



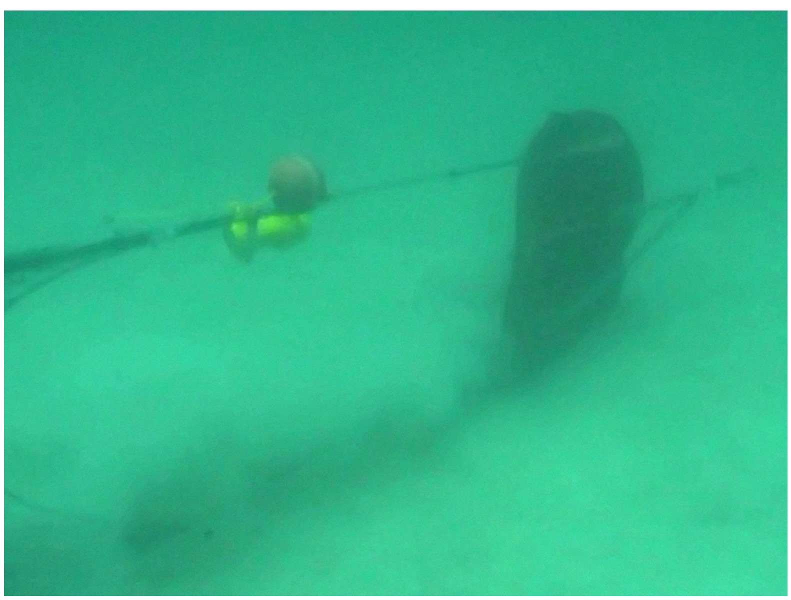
AgriLIFE EXTENSION Texas A&M System
Sea Grant

Net Attachment Positions for 1.4m² Door



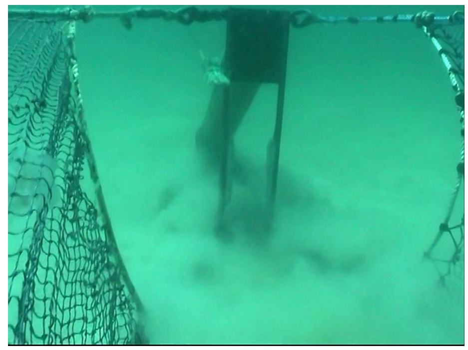
AgriLIFE EXTENSION Texas A&M System — Sea Grant

Aft View of the 1.1m² Door with a 55 ft. Mongoose Net



AgriLIFE EXTENSION Texas A&M System — Sea Grant

Two Views of the Sled in a Double-rigged Trawl System



Replacement Considerations for Cambered Doors

- **Cambered doors should be roughly ½ as long as what you now pull, but net size, style, and material also influence door size. For example, a 45' nylon net requires 1.4m² doors but that same net made from Spectra® or Sapphire® can be spread with 1.1m² doors.**

- **Evaluation by elite fishermen suggest the following rules of thumb:**
  - **If you are pulling 4 – 40' to 45' nets, then use 1.1m² doors**
  - **If you are pulling 4 – 45' to 50' nets, then use 1.4m² doors**

- **Sea trials of doors required to spread 4 – 50' to 55' nets are preliminary and suggest that 1.4m² doors are marginal at the 2nd tow point. Sea trials of doors required to spread 4 – 55' to 60' nets have not yet taken place.**

- **Choose the door size that allows your nets to spread fully when the doors are pulled from the front-most towing point (the smallest angle of attack). The smaller the angle of attack, the greater the fuel economy!**

- **Cost differences between 1.1m² and 1.4m² & 1.4m² and 1.6m² doors are $50 per door, a minor issue. When in doubt, choose the next larger size.**

Sapphire® Webbing

- Characteristics:
  - High-density polyethylene
  - Small-diameter, high-tensile-strength material
  - Fibers are braided, not twisted.
  - No dipping requirements like nylon webbing.

- Results:
  - Captain Manuel Calderón reports ½ to 1 gal. / hr. savings when comparing Sapphire® to Spectra®.
  - Captain Louis Stephenson reports 1½ gal. / hr. savings when comparing Sapphire® to nylon.
  - Captain Tim Adams reports 1 gal. / hr. savings when comparing Sapphire® to nylon.
  - Captain David Chauvin reports 1 gal. / hr. savings when comparing Sapphire® to nylon.

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Moving from "Breakthrough" to Broad-scale Evaluation Across Industry

- <u>Intensive Technical Assistance</u>
  - Tim Adams – Bon Secour
  - David Chauvin – Chauvin
  - Gold Coast – Palacios
  - Juan Gaona – Brownsville
  - Eddie Garcia – Palacios
  - Bobby Pendarvis – Irvington
  - Jeff Vu – Palacios
  - Tom Williams – Tarpon Springs

- <u>Texas Energy Conservation Office</u>
  - Delbert Bull, Jr. – Sabine Pass
  - Charles Burnell – Brownsville
  - Manuel Calderón – Freeport
  - Frank Lasseigne – Brownsville
  - Ralph Rawlings – Matagorda
  - Marcelino Ochoa – Brownsville
  - Louis Stephenson – Hitchcock

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Helping Cooperators Address the "Learning Curve" for Cambered Doors

- In more profitable times, most operators could experiment with the new doors and reach production equivalency.
- Today, such experimentation is economically impractical due to:
  - an abbreviated production window
  - record prices – on the high side for fuel and on the low side for outputs
- Elite Consulting Fishermen – Capt. Louis Stephenson (top) and Capt. Manuel Calderón (bottom) – have (i) helped the cadre of cooperators complete their 4-step protocols and (ii) sped conversion to this new gear.

AgriLIFE EXTENSION Texas A&M System

Sea Grant

Study Protocol for Evaluating New Gear

- Approach
  - Cooperator selects a <u>knot speed</u> and holds it (±) throughout all four steps
  - Each half hour the cooperator records:
    - Time of day
    - Actual knot speed
    - RPM
    - Fuel consumption (from the fuel-flow meter)
    - "Current" sea conditions (<u>W</u>ith, <u>A</u>gainst, <u>S</u>lack)
  - Eight 3½ hr. tows are required for steps 1,2, & 4.
  - 15 good tows per side are required for production equivalency step.
- Cooperator implements the approach across a 4-step procedure.
  - Step 1 – Baseline (current complement of nets and doors)
  - Step 2 – Sapphire® nets spread with traditional doors.
  - Step 3 – Side-by-side prod. equivalency (traditional vs. cambered)
  - Step 4 – Sapphire® nets spread with cambered doors.

AgriLIFE EXTENSION Texas A&M System

Sea Grant

Expected Benefits

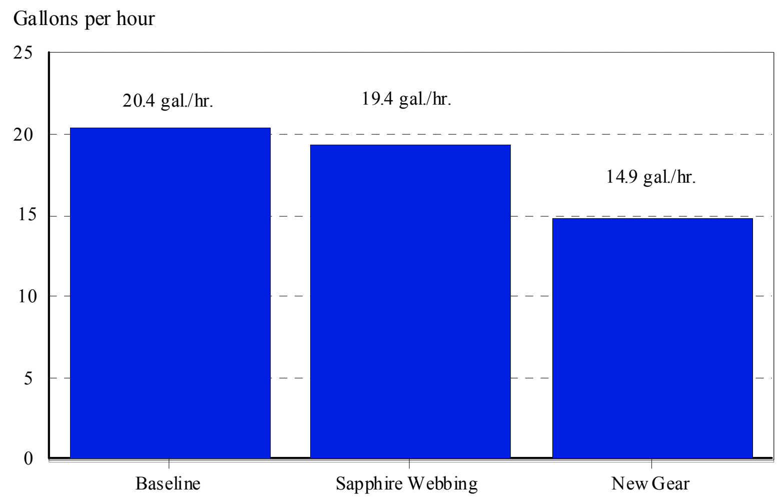
- Immediate economic benefit
  - The cambered, vented doors reduce resistance and require fewer RPM to generate desired towing speed. Across the offshore fleet, reported reductions in gallons per hour range from 10% to 39%!
- Engine maintenance
  - A slower-turning engine generates fewer "engine hours" than a faster-turning engine if run for the same amount of time. If operators follow prescribed maintenance based on "engine hours" then:
    - oil changes are required less frequently and
    - major overhauls occur less frequently. (Fleet managers estimate moving from an 8 to an 11 year interval.)
- Environmental stewardship
  - Cambered doors create a smaller "footprint" on the sea floor
  - Smaller carbon "footprint" with reduced fuel consumption

AgriLIFE EXTENSION Texas A&M System — Sea Grant

David Chauvin & The F/V Mariah Jade

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Documented Fuel Consumption Aboard the F/V Mariah Jade across the Four-step Protocol (… a 5% & 27% reduction)



AgriLIFE EXTENSION Texas A&M System — Sea Grant

Summary & Conclusions (1)

- **This new trawl gear generates immediate, significant fuel savings across offshore shrimp trawlers.**

  ? **<u>Sammy Snodgrass (fleet):</u> 375 hp. pulling 4 – 42 ft. nets reduced fuel use by 29 to 39%.**

  ? **<u>Western Seafood (fleet):</u> 500 hp. pulling 4 – 47½ ft. nets reduced fuel use by 28 to 33%.**

  ? **<u>David Chauvin, F/V Mariah Jade:</u> 300 hp. pulling 4 – 32 ft. nets reduced fuel use by 27%.**

  ? **<u>Louis Stephenson, F/V Master Brandon:</u> 500 hp. pulling 4 – 50 ft. 2-seam nets reduced fuel use by 20% inshore & 24% offshore.**

AgriLIFE EXTENSION Texas A&M System — Sea Grant

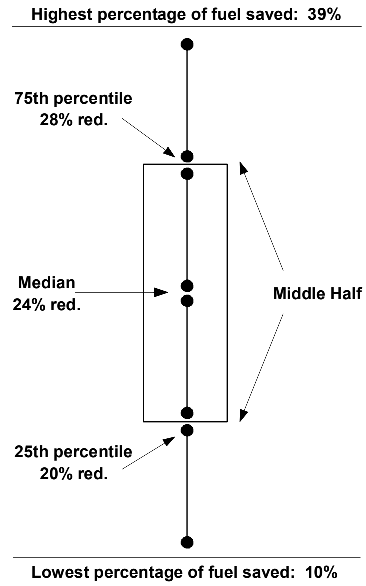
Summary & Conclusions (2)

¦ Thus far, the total documented range in fuel savings is 10% to 39%. Consider the “middle half” of that range.

  ? The median fuel-savings value is 24%.

  ? 25% above and below that mid-point we find a 28% savings and a 20% savings.

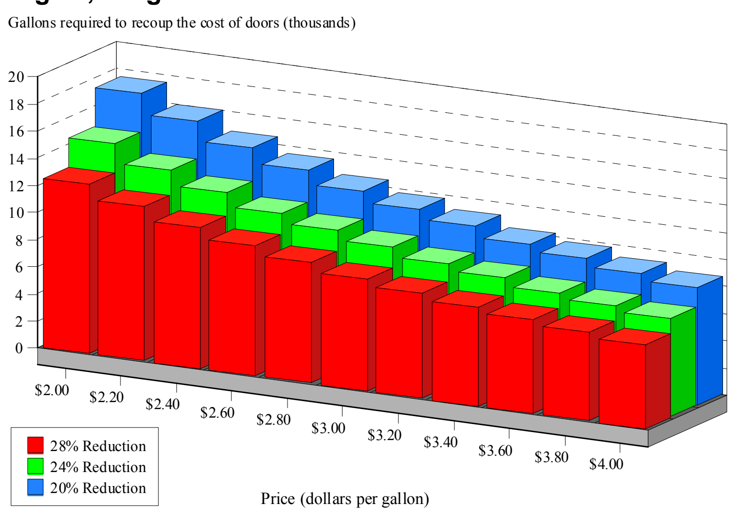
  ? This “middle 50%” of fuel-savings values (20% – 28%) is the range in fuel-savings most operators can expect!



AgriLIFE EXTENSION
Texas A&M System
Sea Grant

Summary & Conclusions (3)

¦ Four doors cost $7,000. With fuel @ $2.40/gal. and with a 20% reduction, you will recoup the investment after burning 14,583 gal.; with a 24% reduction after burning 12,153 gal.; and with a 28% reduction after burning 10,417 gal.



AgriLIFE EXTENSION
Texas A&M System
Sea Grant

Summary & Conclusions (4)

Gallons you must use to pay for the doors given (i) different unit diesel prices & (ii) different levels of fuel saving within the "middle" 50 percent of reported savings by industry			
$ / gal.	20% Reduction	24% Reduction	28% Reduction
$2.00	17,500	14,583	12,500
$2.20	15,909	13,258	11,364
$2.40	14,583	12,153	10,417
$2.60	13,462	11,218	9,615
$2.80	12,500	10,417	8,929
$3.00	11,667	9,722	8,333
$3.20	10,938	9,115	7,813
$3.40	10,294	8,578	7,353
$3.60	9,722	8,102	6,944
$3.80	9,211	7,675	6,579
$4.00	8,750	7,292	6,250

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Summary & Conclusions (5)

¦ Other benefits also accrue with more fuel-efficient gear.
  ? Engine-oriented benefits:
    ? More time between oil changes
    ? Can extend time between major overhauls from 8 to 11 yrs.
  ? Environmental benefits:
    ? Reduced footprint on seafloor due to shorter door length
    ? Reduced carbon footprint

¦ Cambered doors neither help nor hurt shrimp production. The new gear catches the same amount of shrimp but with lots less fuel!

¦ In certain ports conversion to cambered doors and Sapphire® webbing has been rapid. Roughly 80% of the Brownsville/Port Isabel fleet (132 vessels) has already converted to the new trawl gear.

¦ The search for efficiency is a journey … not a destination! This Spring we will evaluate the contribution a skewed wheel makes to fuel conservation while running and during trawling with the new gear.

AgriLIFE EXTENSION Texas A&M System — Sea Grant

Questions … Comments

AgriLIFE EXTENSION
Texas A&M System

Sea Grant

Appendix IV – Producer Survey from the North Carolina Workshop Series

Sea Grant
Texas Sea Grant Extension

Texas A&M University Sea Grant College Program ● Texas AgriLife Extension Service ● The Texas A&M University System

Texas AgriLife Research & Extension Center
10345 State Hwy. 44
Corpus Christi, Tx 78406-1412
Tel: 361/265-9203
Fax: 361/265-9434
E-mail: m-haby@tamu.edu

May 19, 2008

FIELD(1) FIELD(2) FIELD(3)
FIELD(4)
FIELD(5), FIELD(6) FIELD(7)

Dear FIELD(1) FIELD(3):

Several weeks ago we conducted a series of workshops about new trawl doors and braided webbing. These meetings were held to discuss and demonstrate a new type of door and low-cost braided webbing that is saving a significant amount of fuel (20 to 39 percent) with no decrease in production.

All of us – Gary Graham, Bob Hines, Patrick Riley, Captain Louis Stephenson and I – really enjoyed conducting the five workshops and we really appreciate your attendance.

We are constantly seeking ways to improve what we do for the seafood industry. I have enclosed a short evaluation to get your impressions of what we did, and how useful you feel our fuel-saving trawl gear workshop was to you. Would you please take a minute to fill out the evaluation and return it in the stamped envelope?

Thanks again for your participation. If we can answer any questions you may have about the doors or the braided Sapphire® webbing, please contact us.

All the best to you and yours,

Michael G. Haby
Professor & Extension Economist – Seafood

File: Cover-letter_NC-trawl-gear-workshop-eval.wpd

Attachments: Fuel-efficient_trawl-door_workshop-eval.wpd
Stamped, addressed envelope

Evaluation of the Fuel-efficient Trawl Door Workshop

held April 21 – 25, 2008

Your thoughts about this meeting will help us improve what we are doing. Please take a moment to answer these questions. It helps us make our work more valuable to you.

Please check the box for each statement that best describes your impressions of this workshop.

After attending this workshop...	Strongly Disagree	Disagree	Agree	Strongly Agree
I understand the fuel savings other fishermen have experienced with this new trawl gear.				
I understand how to connect the new doors to my towing bridles and nets so they will produce equally to the gear I normally use.				
I understand how to troubleshoot improper connections between towing bridles, doors, and nets.				
I understand how to determine the size of cambered doors needed to replace my wooden or aluminum doors.				

Please check the box for the statement that best describes your thoughts about this workshop.

STATEMENTS	Strongly Disagree	Disagree	Agree	Strongly Agree
Attending this trawl door and webbing workshop was important to me.				
The speakers and the demonstrations were informative.				
The information about these new doors and the braided Sapphire® webbing was practical to my operation.				
I can use what I learned in my operation.				
Overall, this was a very educational workshop.				

What will you do with the information you received at the workshop you attended?

PRACTICES	Yes	No
I have (or will) review the handout material provided at the meeting.		
I have (or will) watch the DVD of how the fuel-saving gear performed.		
I will consider changing to the new cambered doors and Sapphire® webbing.		

Please rate the quality of this workshop & demonstration.

	Excellent	Good	OK	Poor
Discussion & demonstration about properly sizing and rigging the new doors.				
Slide presentation.				
Handout materials (copy of presentation & DVD).				

Please tell us about you.

How many gallons of fuel do you burn each year aboard your vessel(s)?

_______________ GALLONS USED EACH YEAR

What size are the trawl doors you now use?

____

How many years have you commercially fished?

__________ YEARS

Did you apply for Trade Adjustment Assistance through the Farm Service Agency in 2004 or 2005?

_____ YES
_____ NO

Please provide any additional comments about this workshop in the space below. Thanks!

Appendix V – Popular Press Articles from *Seafood Business* and *National Fisherman*

SeaFood BUSINESS

Shrinking the carbon footprint - June 3, 2009
Distributor focus on reduced carbon pays off; harvesters work to increase fuel efficiency
By Lisa Duchene

John Rorapaugh is working on a monster project, so far tackled only by a few in the seafood marketplace. Rorapaugh, who handles sustainability for ProFish, a Washington, D.C., distributor, is trying to place a carbon score upon each of the company‚Äôs more than 700 products.

Called ‚ÄúCarbon Fishprint,‚Äù the labeling program takes into account criteria like whether the product is farmed or wild, the harvest method and gear type, its origin, the type of energy powering the production facility and whether the product was trucked or air-freighted.

Items accumulate points for carbon-intensity in each of the categories, up to a theoretical 50 points for an extremely high carbon-intense seafood product, says Rorapaugh. A Virginia croaker caught by hook and line is a ‚Äúshining example,‚Äù of a low-carbon product, says Rorapaugh, and likely to score a six, while so far others deemed especially carbon-intensive like air-freighted Pacific bluefin tuna net a score of 38.

‚ÄúI know that [carbon tracking is] the future,‚Äù says Rorapaugh. ‚ÄúI see it and Greg [Casten] and Tim [Lydon], both the owners, realize it.‚Äù

Rorapaugh and ProFish embarked on the project for customer Bon Appetit Management, a foodservice company in Palo Alto, Calif., which two years ago launched an effort to cut the carbon footprint of its food supply by 25 percent.

That meant pushing its 30 seafood suppliers to provide information on how the seafood was harvested and transported, as well as how products compared on carbon dioxide emissions.

‚ÄúThrough them, we started changing our buying practices,‚Äù says Rorapaugh. The company is sharing carbon-emissions information with its other customers.

ProFish carefully orchestrates its truck routes for efficiency, purchases wind power for its warehouse, pushes suppliers to use recyclable cardboard instead of Styrofoam, and hopes to install mirrored tubes vertically along its warehouse walls to allow sunlight to fill the building and provide daytime lighting. Its goal is to become a carbon-neutral company.

The effort is just one example of how seafood‚Äôs carbon footprint may be shrinking, although it‚Äôs impossible to put a number on the current size or reduction. Assigning a carbon rating to a seafood product is hardly an exact science ‚Äî something Rorapaugh is the first to admit. Yet, some measure of the carbon dioxide emissions represented by a product is becoming an important factor in the sustainable foods marketplace. Carbon dioxide is one of the greenhouse gases warming the planet. Today, atmospheric carbon dioxide concentrations are estimated to hover around 385 parts per million. NASA climatologist James Hansen advises a limit of 350 ppm to avoid ‚Äúirreversible catastrophic effects,‚Äù adding additional urgency to the effort.

In the Gulf of Mexico, and in waters off Maine and Alaska, fishermen are using energy-efficient practices and technologies to help save fuel costs. Fish feed companies are working on formulations to reduce the amount of fishmeal in aquaculture diets; less fishmeal tends to mean a lower carbon footprint.

Nearly all of the seafood Bon Appetit buys ‚Äî an amount the company does not release ‚Äî is transported by truck or ship, instead of by air.

Bon Appetit serves 80 million meals annually at 400 cafes in 29 states and since 2002 has been purchasing only seafood rated ‚Äúgreen‚Äù or ‚Äúyellow‚Äù by the Monterey Bay Aquarium Seafood Watch guide.

The company is 90 percent compliant with its goal to eliminate all air-freighted seafood, explains Helene York, Bon Appetit‚Äôs director of strategic initiatives.

‚ÄúFor us, the most interesting aspect of this initiative has been our work with seafood suppliers,‚Äù says York.

‚ÄúSuppliers are genuinely interested in trying to fairly represent their products as less carbon-intensive than other products.‚Äù

The key to cutting seafood‚Äôs carbon footprint is to use it regionally and seasonally because that approach cuts transportation-related emissions, says York.

On the water, there are several initiatives to reduce seafood‚Äôs carbon footprint. Record-high fuel prices of 2008 prompted many fleets to seek ways to cut fuel usage.

In the Gulf of Mexico, some shrimpers are saving between 10 and 28 percent with the use of new trawl doors, the weights that keep the net open and low to the bottom for catching shrimp.

The experimental doors were adapted from an Icelandic design, says Gary Graham, a marine fisheries specialist with Texas Sea Grant in West Columbia, Texas. The doors have squared bottoms and curved tops to reduce their drag in the water. The new design, first tested in 2005, costs about $7,000, comparable to traditional rectangular-shaped doors. But the design allows a 20 percent savings, or about 10,000 gallons of diesel fuel, off the typical Gulf shrimp boat‚Äôs average fuel use of about 50,000 gallons annually. Western Seafood, in Freeport, Texas, initially spotted the design in Iceland and has worked with Sea Grant and shrimpers to help adapt it for the Gulf, says Graham.

Fishermen out of Port Clyde, Maine, have also been testing various gear changes that reduce their boats‚Äô drag in the water and fuel use, says Steve Eayrs, a research scientist at the Gulf of Maine Research Institute. Some boats have lightened their sweeps, or rubber ground gear that keeps the nets off the bottom, and increased the mesh size in the cod-end of the net from 6.5 inches to 7 inches to reduce drag.

Eayrs plans this summer to measure the fuel savings the changes represent and encourages fishermen to install a fuel flow meter so they can see in real time how little changes saves fuel.

‚ÄúIt‚Äôs quite interesting that all these benefits can be realized by a relatively modest change in fishing gear,‚Äù says Eayrs.

In some parts of Alaska, the price of diesel fuel reached $7 per gallon in 2008. Most of the 126 fishermen who responded to a fall 2008 online survey from Sea Grant‚Äôs Marine Advisory Program said they had spent less time on the water prospecting for fish, stayed closer to home and stayed on the grounds longer. Many carefully planned routes, eased off the throttle and maintained their boat engines and fuel systems, according to the survey.

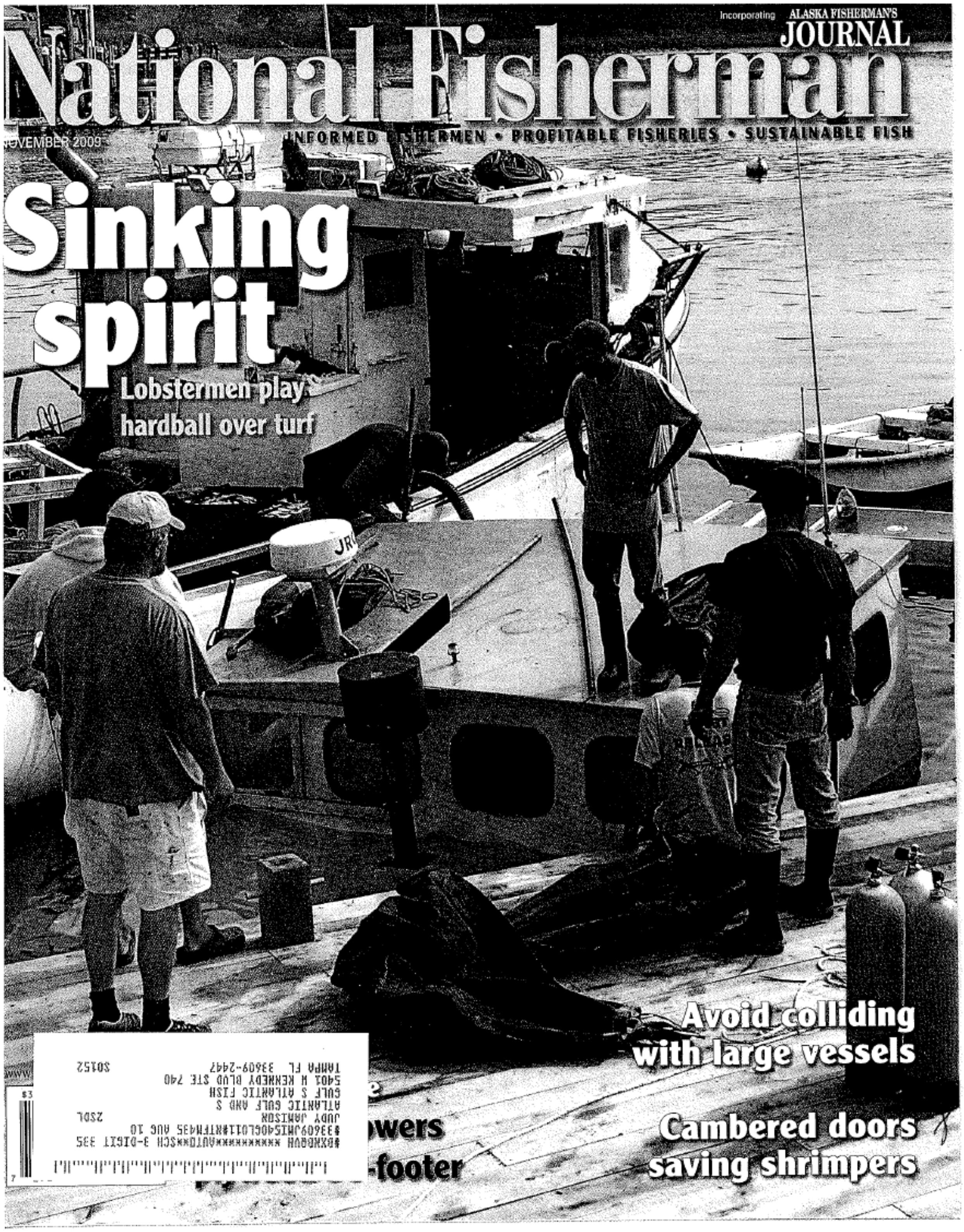
Glenn Haight, a fisheries business specialist with Sea Grant in Juneau, says his sense in talking with fishermen is that the changes will continue, even though fuel prices eased recently.

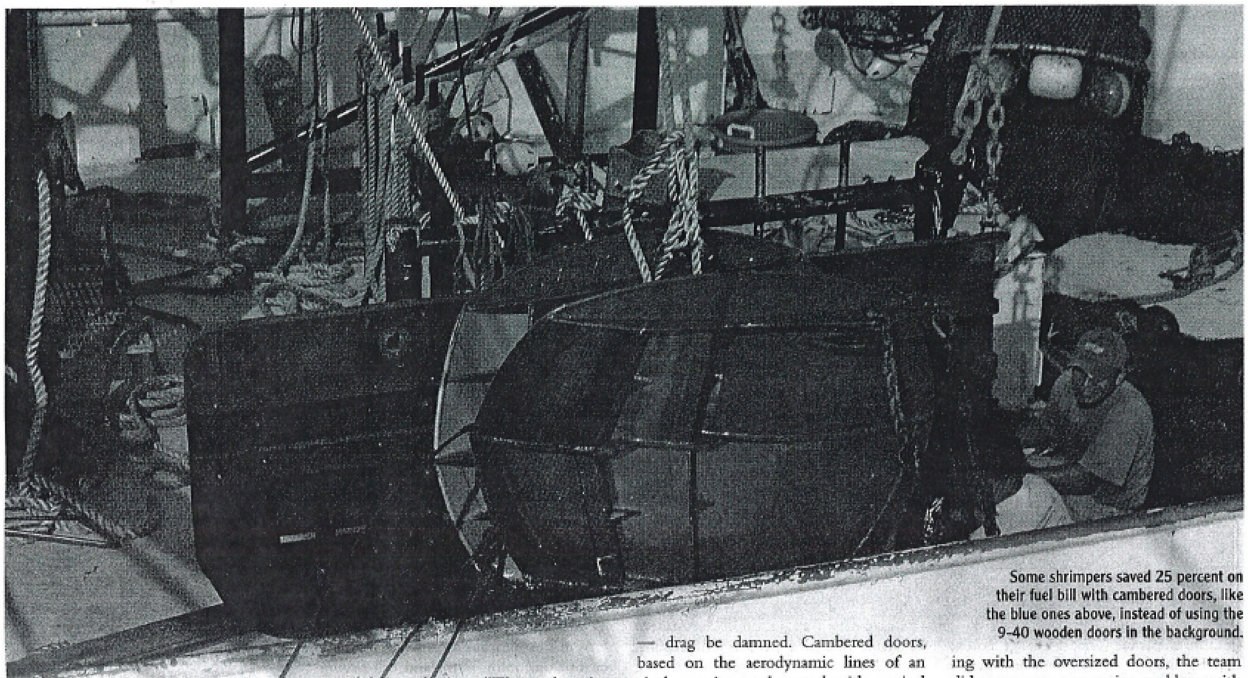
Perhaps efforts like those in Alaska, Maine and the Gulf will translate into value beyond saving money on fuel. Rorapaugh believes the information he is sharing with customers from his carbon-rating project has helped ProFish gain business in a dismal economy.

‚ÄúEverybody‚Äôs talking about down numbers and we‚Äôre not [down]. My sales have grown a lot this year,‚Äù says Rorapaugh.

Contributing Editor Lisa Duchene lives in Bellefonte, Pa.

June 2009


Incorporating ALASKA FISHERMAN'S JOURNAL
National Fisherman
NOVEMBER 2009
INFORMED FISHERMEN • PROFITABLE FISHERIES • SUSTAINABLE FISH
Sinking spirit
Lobstermen play hardball over turf
Avoid colliding with large vessels
Cambered doors saving shrimpers



Some shrimpers saved 25 percent on their fuel bill with cambered doors, like the blue ones above, instead of using the 9-40 wooden doors in the background.

Euro cash

European doors offer savings to southern shrimpers

By Robert Fritchey

Texas A&M University estimates that the state's offshore shrimpers each burn about 64,000 gallons a year. In 1997, at 75 cents a gallon, those 64,000 gallons cost $48,000. By 2006, the price for that same amount of fuel had nearly tripled to $2.20 a gallon or $140,000.

Caught in the crunch between high fuel costs and low dockside prices, roughly 40 percent of the 2,666 trawlers permitted to fish the offshore waters of the Gulf of Mexico stayed at the dock that year.

Then fuel really got expensive.

Luckily, the rising prices caught the attention of a Texas fleet operator who owns an oil delivery business. "We saw the price of oil start to run up, and from what was goin' on around the world, it wasn't gonna stop," says Patrick Riley, general manager at Freeport-based Western Seafood Co.

After visiting Iceland in 2001 and going aboard a large trawler, Riley became intrigued with fuel-efficient European cambered trawl doors. As he worked to adapt those steel doors to the Gulf of Mexico shrimp fishery, Riley brought Texas Sea Grant's Gary Graham on board. Graham not only helped with tuning the doors, but he introduced Riley to some new high-tech trawl webbing.

The use of cambered doors reduced the fuel consumption of Western Seafood's boats by about 25 percent without any loss of shrimp production. (Switching over to Sapphire netting saved another 3 to 9 percent.)

Getting there, however, wasn't easy. Graham characterized the initial trials for the trawl doors in 2005 as "sheer misery" and likened the experience to the advent of quad-rigged trawls in the 1970s. "When the four-rigs came out, it was rough," he says. "Then it took off."

Cambered doors have long been used to harvest finfish in Europe, particularly with midwater trawls. The oval-shaped boards glide over rough bottom more easily than rectangular boards, but the principle advantage stems from their hydrodynamic design.

While traditional flat and rectangular otter boards are relatively inexpensive, they're constructed to get that net open — drag be damned. Cambered doors, based on the aerodynamic lines of an airplane wing, and vented with vertical slots, are designed to spread a trawl while keeping resistance to a minimum. That increased efficiency allows the use of doors nearly half the size of traditional boards, as Riley and Graham found out.

Western Seafood's test boat, the Isabel Maier, had pulled four 47-foot 6-inch Spectra two-seam trawls, rigged with traditional 9' x 40" rectangular wooden boards, better known as 9-40 boards. The team initially tried a set of slightly smaller cambered doors.

As they're from Iceland, the doors are referred to in meters — 2.1-square meters in this case — not feet and inches, though for comparison sake, the wooden doors come out at 2.79 square meters.

But with the tremendous spreading power of the hydrodynamic boards, "It was very obvious that we had too much door. We didn't have enough load for the door to even make it respond right to the water," says Riley. "It took us about six or seven hours to get the doors adjusted just to be able to set them out."

While working with the oversized doors, the team did overcome one major problem with the sled, which in pair trawling holds the inboard wing of each net open.

"We were still using a sled for 9-40 boards and Gary figured out that it was sinking too fast. Out in deep water, you've got your twin rig [on each boom] and they're going out and the doors are completely spread. And you've got this sled in the middle that by the time it reaches the bottom, it might be 10, 20 feet below the trawl doors," explains Riley.

"Well, the net is holding the back end of the sled up, so basically when it reaches down you're driving the nose of it into the ground. That'll make for some nice effects sometimes, especially on a soupy bottom."

To slow the sled's descent, the team initially welded a length of thin-walled stainless pipe to the sled for flotation, but later determined that the same result could be

Captain Manuel Calderón helped make the new trawl doors work.

achieved by simply increasing the width of the sled's shoe.

Upon hitting the dock, after the first tests, Riley ordered a smaller set of doors from Icelandic trawl-gear manufacturer Hampidjan. Manufactured in Spain, the doors had an area of 1.4 square meters — nearly 50 percent smaller than the original wooden boards.

Meanwhile, the Isabel Maier's captain, Manuel Calderón, had taken the 2.1-meter doors on a 24-day trip, "just to play with them," says Riley. "And he learned quite a bit.

The net was opening so wide, Reilly says, "He was catching rigs on either side of him.

"He picked up a lot of knowledge and it really paved the way for later on. If it weren't for him," Reilly says of Calderón, "I don't think any of these results would be here."

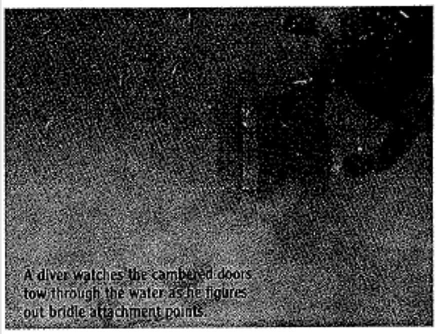
Indeed, when the new boards came in, "everything went off without a hitch," says Riley. "The doors just busted open, went down, and Gary and Manuel and I sat on the back deck and just looked at each other, dumbfounded. It was so easy.

"What it was — and it makes all the difference in the world — they were proportioned, the right size. The doors were loaded right and they operated fine."

With a fuel-flow meter, it had already been established that towing the 9-foot wooden boards at 3 knots, the Isabel Maier's 540-hp 3412 Caterpillar turned 1525 to 1550 rpm and burned 18.5 to 19 gallons per hour.

By comparison, with the properly matched cambered doors, 1400 rpm sustained a 3-knot towing speed and fuel consumption was reduced to 13.5 gallons per hour.

Continued on page 37



A diver watches the cambered doors tow through the water as he figures out bridle attachment points.

Alternative solutions

The cambered trawl doors that worked out for Western Seafood have failed to gain similar acceptance in some other ports, such as Palacios, Texas, where Craig Wallace runs a fleet of six boats.

After one of Wallace's captains tried the boards, "he called in after about two weeks and says, 'Look, I've done everything I could and liked to kill the crew deckin' these things. I can't make these things work.'"

Wallace's captain told him that whenever conditions changed, "Whether it be the current, or the roughness of the sea, he was takin' weight off, puttin' weight on, just doin' things to keep 'em workin' and it was workin' the crew to death."

"My guys do real well with the rigs they've been pullin' for so many years but if you start puttin' too much change on 'em it just causes a mess," Wallace says.

Though he's stayed with wooden doors, "which can be changed with a fence staple and pins," Wallace says that his fleet achieved a fuel savings of about 20 percent by altering those boards and switching from nylon nets to those made of high-density polyethylene Sapphire.

"And we're pulling 2 1/8 [-inch] mesh instead of 1 7/8," he says. "We pull 50-foot nets, so that's really been a big savings for us."

Wallace also reduced the size of his boards and widened the gap between the wooden slats on the doors, "so the water goes through the door better but it still gets a spread. And we've lightened up on our towing speed.

"We've been able to drop off 150 rpm, basically pulling the same net, but we used to pull 10-42 doors, now we're pulling 9-40s, so that's lightened our rig up. So that's kind of what we've gone to, to try to save fuel."

In hindsight, Wallace wonders whether the 1.4-square meter steel doors he tried matched his 50-foot nets, and acknowledged that his captains had only received dockside instruction in their setting and use. **— R.F.**

and cultural presentations can be made.

Alvin Sibley, a builder of wooden boats, recently built a new bottom and installed a house and stern on an oyster boat for Ben Reynolds of Warsaw, Va., at Best Boatyard.

The boatyard is a relatively new facility on the Rappahannock River near Saluda, Va. Sibley put staving in the bow of the 26' x 7' wooden boat and then rebuilt the rest of the bottom.

The old staving was 3/4-inch-thick pine and the rest of the bottom was 1-inch pine. The wood that went back in was thicker 1 1/4-inch salt-treated pine for the staving and 1 1/4-inch wide-grain, short-needle pine planks for the rest of the bottom. "She's got nice lines, and with a thicker bottom, I think she will provide a more stable platform," says Sibley.

He also put in a new white-oak keel and shaped the stern with pine planks. Other work included a rebuilt shaft alley and new engine beds for a Chrysler inboard engine. — *Larry Chowning*

For contact information on companies in Around the Yards, see page 45.

Boats&Gear
Sustainability

Continued from page 33

After documenting the fuel savings, the team conducted shrimp production equivalency tests by pulling with the new steel doors on one side and the original wooden doors on the other.

In spite of the fact that Simrad equipment showed an increased door-to-door spread of 2.5 feet, at the minimum setting on the steel doors, the new rig produced nearly 20 percent less shrimp than the old setup.

"What we figured out is the shoes on these steel doors are oval at the bottom and the attachment point for the leadline was basically about eight inches off the ground. So that's what was killin' us," Riley says.

To bring the leadline down to the sea floor — especially important with bottom-hugging brown shrimp — the original shoe was replaced with a rectangular shoe, with an attachment point right on top.

Since the doors were originally built for fish trawls that have cork and leadlines of equal length, the attachment point for the towing cable was located directly in the center of the door.

With a bottom trawl, and its longer leadline, the doors tended to lean, which, again, pulled the leadline off the bottom. So the doors were further modified to accept a two-chain bridle set to check excessive spreading.

With the doors fully modified and tuned, final testing revealed an increase in the shrimp catch of about 2 percent.

The fully modified doors are now available through Marine & Industrial Specialties, a subsidiary of Western Seafood in Freeport. After having the boards manufactured in several locations, including in-house, the least expensive source proved to be China.

"What it's been able to do is allow these guys to afford them, at $6,500, $6,600 a set [of four] for 1.1s, 1.4s," says Riley, who says most of the Brownsville and Port Isabel, Texas, fleets had converted to the doors. "I know we've sold over 140, 150 boats worth down there."

While many fishermen could, within a season, work out the kinks in the new gear on their own, Sea Grant's Graham advises, "I wouldn't think of trying it without bringing an elite fisherman over to set you up."

Western Seafood's Manuel Calderón and Lewis Stephenson, of Hitchcock, are Texas Sea Grant's "consulting elite fishermen," who work with Graham to help fishermen along the Gulf rig up and troubleshoot the steel doors.

Grant money made it possible for the two skippers to travel to other ports. Graham says that the grant money would be used up by the end of August but he is applying for an extension.

Various other loans, grants and pilot programs are expected to become available in the gulf and South Atlantic states. Interested fishermen should contact their Sea Grant or state fishery agencies for details.

To help in establishing the grants, Sea Grant has sent its consulting captains across the gulf and South Atlantic coasts to set up other fishermen, and to reliably document their fuel savings under local conditions. Some of those results, and other information on cambered doors, are available in Texas Sea Grant's paper, "Improving Fuel Efficiency in the Gulf & South Atlantic Shrimp Fishery," on the Internet.

Also available online is a "A Cost-Benefit Analysis of Gear Replacement for Gulf Shrimp Fishermen." It was commissioned by the Ocean Conservancy and estimates payback times for converting to the new doors and trawls.

Texas Sea Grant is also working to develop an instructional video. NF

Robert Fritchey is at work on his second book, "Gulf Wars," about the net bans battles of the 1990s. He lives in Golden Meadow, La.

Boats&Gear
Safety

Continued from page 31

Gelinas adds.

At sea in the daytime, Johnson says there is a light area above the horizon and a dark area below the horizon. You'll find another ship on the horizon, but a small boat will be in the dark area. "It's much more difficult to pick out, so the first issue is just seeing it," he says.

And that's with good visibility. In fog or reduced visibility, it's that much more difficult to see a boat, notes Johnson, adding that "a lot of fishing boats don't show up well on the radar, especially with some wind and sea conditions. So I might not have any idea they are out there."

And speaking of limited visibility, a fisherman shouldn't make the assumption that a merchant ship is slowing down because it is foggy. "Merchant ships are out there to make money and you don't do that going slow. There pressure there to hold the speed," Johnson says. "Though as a pilot I slow down because the commercial pressures are less than safe navigation."

Chase notes that the "rules of the road" say to operate at a safe speed, "but they don't tell you how fast that is. I would say that most big ships run at sea speed through the fog."

Sea speed for merchant ships varies from 13 to over 20 knots. That's about 85 percent of the engine's output, says Johnson. Maneuvering speed is slower —10 to 11 knots. Once a merchant ship reaches open water it takes about 30 minutes to get up to sea speed, and "I need 15 minutes to come to maneuvering speed [from about 14 knots] though in an emergency I can do it faster," Johnson says.

And don't expect the merchant ship to suddenly stop if your fishing boat is in the way. Putting a merchant ship into reverse at 11 knots has no effect. "It would go miles before stopping," Johnson says. "You've got to get to six to eight knots to start astern, and once the engine goes astern you lose all control over the ship."

All of this is another way to point out why, "The fishing boat has to see and contact the ship rather than the other way around," Johnson says. "It's the more likely to succeed method." NF

Michael Crowley is the Boats & Gear editor for National Fisherman.

Appendix VI – Announcement about the Gulf of Mexico Shrimp Fishery Improvement Roundtable Pilot Program Available to Help Producers Adopt the New Fuel-saving Trawl Gear

Gulf of Mexico Shrimp Fishery Improvement Roundtable

Increasing Fuel Efficiency Through the Use of Cambered Steel Trawl Doors and Nets

Replacing traditional wood trawl doors and nylon nets with steel cambered doors and lighter sapphire nets on shrimp trawl vessels can reduce fuel consumption by up to 39 percent. Shrimp boats using these new doors and nets decrease drag and in turn produce fewer RPMs to reach desired towing speed. In economic terms, total fuel savings are significant, with the average vessel saving 6,000 gallons of diesel, or $28,000 in fuel on an annual basis. With this level of fuel saving potential, the new doors and nets pay for themselves before the first full fishing year; over the 5-year life of the gears the net benefit to vessel owner is $104,000.

Fuel-efficient steel cambered doors

Texas A&M researchers have found that because steel cambered trawl doors improve engine efficiency, oil changes and major overhauls are not needed as frequently. Furthermore, the carbon footprint of the shrimp industry can be reduced through more fuel efficient gear.

Cost of Gear:

Steel doors: $7,000
Dummy doors/sleds: $800 x 2=$1,600
Nets: $1,500 avg. per net x 4 = $6,000
BRDs: $400 avg, x 4=$1,600
Fuel flow meter: $1,500
Total Gear Conversion Costs per Boat = $17,700
Cost Covered by Shrimp Fishery Improvement Roundtable = $8,850
Balance = $8,850

The Roundtable will also will also provide an experienced Captain to assist with installation of the gear, and training on how to use the nets and doors effectively. A Captain will be provided for up to 5 days, although it may not take that long. In addition, we will provide **$500 a day (up to 5 days)** during the training to offset the costs of boat operation during training.

Contacts:

Kathryn Novak, Sustainable Fisheries Partnership - 813-482-7146
Chris Dorsett, Ocean Conservancy - 512-542- 7431

Appendix VII – Texas Parks and Wildlife Promotional Bulletin about the Cambered Doors

New gear will save you fuel and money.

Investing in **new gear** can **reduce fuel consumption** up to 15,000 gallons a year.

A switch to **steel cambered trawl doors** and **sapphire nets** could mean:

- Average fuel savings of 20% a year
- Longer lasting doors and nets
- Less wear on engines
- Lower maintenance costs

Better performing **bycatch reduction devices (BRDs)** could mean:

- Lower bycatch, less discarding
- Fewer crushed shrimp
- Faster sorting
- Expanded markets for sustainable product

Don't forget: As of May 2009, new rules may require your BRDs be replaced or modified for vessels fishing federal waters.

TEXAS PARKS & WILDLIFE

To learn more:
Contact Tonya Wiley (281-534-0131), Art Morris (361-825-3356)
at Texas Parks and Wildlife or Gary Graham (979-345-6131) at Texas Sea Grant

Sea Grant Texas

DỤNG CỤ MỚI SẼ ĐỂ DÀNH ĐƯỢC NHIÊN LIỆU VÀ TIỀN CHO BẠN.

Đầu tư vào dụng cụ mới có thể giảm đi nhiên liệu xài đến 15 ngàn ga lông cho mỗi năm.

Một thay đổi để xài **đôi đo sắt cong** (trái trứng) và **lưới tôm loại sắp-phai** có nghiã là:

- Để dành trung bình 20% nhiên liệu cho mỗi năm
- Lưới và đo sẽ xài được bền hơn
- Ít hao mòn máy
- Tiền bảo trì thấp

Lọc cá làm việc tốt hơn có nghiã là:

- Bắt cá ít hơn - Vứt bỏ ít hơn
- Tôm ít bị đè bẹp hơn
- Lựa tôm nhanh hơn
- Thị trường mở rộng cho sản phẩm bền lâu hơn

Xin đừng có quên: Bắt đầu từ tháng 5, 2009 luật mới có thể bắt bạn phải thay lọc cá hoặc sửa đổi lọc cá nếu bạn đánh tôm trên vùng nước của chính phủ Liên Bang.

TEXAS PARKS & WILDLIFE

Muốn biết thêm:
Xin liên lạcTonya Wiley (281-534-0131), Art Morris (361-825-3356)
at Texas Parks and Wildlife or Gary Graham (979-345-6131) at Texas Sea Grant

Sea Grant Texas

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Director, Texas AgriLife Extension Service, The Texas A&M University System. 02-10