THE SOUTHEASTERN UNITED STATES EXPERIENCE WITH THE INTRODUCTION AND ACCEPTANCE OF NEW SUSTAINABLE TECHNOLOGIES

John W. Watson
NOAA Fisheries
P.O. Drawer 1207
Pascagoula, MS 39567 USA
Tel. (601) 762-4591, Fax (601)769-8699
e-mail: jwatson@triton.pas.nmfs.gov

ABSTRACT

The discarding of unwanted and undersize bycatch and the inadvertent capture and mortality of protected species are significant problems for fisheries in the Southeastern United States. The penaeid shrimp trawl fishery has been identified as a significant source of sea turtle mortality and discard of unwanted bycatch which impacts sustainability of managed fish stocks. The U.S. Congress passed two laws; the Endangered Species Act (ESA) which in 1978 mandated the protection of threatened and endangered sea turtles and the Magnuson Conservation and Management Act (MCMA) mandating the recovery of overfished stocks. These laws had a direct impact on the Southeastern U.S. shrimp trawl fishery and resulted in intensive programs to develop and implement sustainable fishing technologies. The result of these programs has been the development and implementation of Turtle Excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs). TEDs (trawl modifications which allow the escape of sea turtles and other large animals from trawls) were developed and tested between 1978 and 1988 and were implemented in 1989 through mandatory regulations but not without difficulty and adversarial confrontation between fishers and fishery researchers and regulators. Successful implementation required five years of intensive enforcement, refinement of technology, and technology transfer efforts. Improvements in communication, technology transfer efforts, and cooperation between fishery researchers and commercial fishers have resulted in significant improvements in TED technology and compliance with regulations. Recent surveys and estimates of sea turtle populations indicate sea turtle populations are recovering as a result of conservation measures including the use of TEDs by commercial fishers.

Lessons learned from the TED experience have been applied to the development and implementation of BRD technology (trawl modifications to reduce fish bycatch). A comprehensive program of gear development and testing was developed in 1992. An integral component of the program was the participation of commercial fishers in the development, testing, and evaluation of sustainable fisheries technology. The program included a comprehensive research requirements document, research plan, and standardized testing protocol. The program was monitored by an industry/government advisory panel and technical review panel and included participation by state and federal agencies, industry organizations, and individual fishers. The result of the program has been the development of sustainable fishery technologies which have been recently successfully introduced in the South Atlantic in both state and federal waters and are scheduled for implementation in the Gulf of Mexico in 1998.

The discard of bycatch by the Southeastern United States penaeid shrimp fishery became a concern in the early 1970's as fish stocks became fully exploited or overutilized by commercial and recreational fisheries. Declining landings for many species resulted in regulations restricting catches in order to maintain and rebuild depleted fish stocks. The competition between user groups for available resources focused attention on the discard of bycatch by the shrimp fishery. Studies conducted in the 1980's and early 1990's found that the discards by the shrimp fleet were significant. Stock assessments indicated that several finfish species were under severe stress and timely recovery of the stocks would require reduction in shrimp trawl bycatch mortality.

Development and Introduction of Turtle Excluder Devices (TEDS)

In 1978 all species of sea turtles which occur in the Southeastern U.S. were listed as threatened or endangered under the U.S. Endangered Species Act (ESA) which mandated their protection. Several studies including a report by the U.S. National Academy of Sciences, National Research Council (1990) found that the penaied shrimp fishery was the single largest source of sea turtle mortality. The implications of the ESA represented potentially severe consequences for the valuable shrimp fishery including draconian closure of the fishery. The incidental capture and mortality of endangered sea turtles by the shrimp fishery took precedence over other bycatch issues and available resources were allocated to develop solutions to this problem. A government research effort was initiated in 1978 to develop potential solutions. Alternatives considered included; area and seasonal closures, restricted tow times, and gear modifications. Area and seasonal closures were considered politically and economically unacceptable and tow time restrictions were not effective.

An intensive gear development program was conducted between 1978 and 1980 which resulted in the development of the "turtle excluder device" (TED). The TED was developed by gear technologists working with ideas developed by commercial fishers to exclude jellyfish from their catch. The original TED design was a metal grid installed in the trawl extension which mechanically separated and excluded sea turtles and other large bycatch objects and organisms. In 1981 fishery managers initiated a program to encourage the voluntary use of TED technology by the shrimping industry. A technology transfer program was developed which included industry workshops and demonstrations. TEDS were manufactured by commercial companies under government contracts and distributed to fishers for trials. The technology was not widely accepted by fishers who expressed concerns that the gear was to large, cumbersome, and complicated. Research and development continued between 1980 and 1984 to improve the handling characteristics of the gear and modifications were made to reduce fish bycatch as an incentive to encourage voluntary use. In 1985 and 1986, technology transfer efforts were increased to encourage voluntary use of the TED technology. Successful demonstrations of the technology were conducted but widespread voluntary use of the technology did not occur. In 1986, environmental protection organizations filed intent to sue federal agencies if the endangered species act was not fully enforced. Their complaint stated that the voluntary TED program was not effective and sea turtles were not being adequately protected. In response, federal regulators called for a mediation meeting between representatives of the shrimping industry and environmental protection groups. The results of the mediation meetings formed the basis for regulations requiring the mandatory use of TED technology by a large segment of the shrimping industry. The proposed mandatory regulations ended voluntary use of TEDS and

resulted in a strong campaign from segments of the industry in opposition to mandatory use of TEDS. The proposed mandatory use of TEDS also resulted in the development of alternative designs by fishers. The new designs were cheaper, less complicated and easier to use, but were less effective in retaining shrimp catch. The implementation of TED technology into the shrimp industry through mandatory regulations was met with intense opposition from the shrimp industry which included political pressure, litigation, adversarial confrontation, and civil disobedience. The industry resistance and opposition resulted from several factors which included; fear of reduced revenue and economic hardship, denial and disbelief of the magnitude of the sea turtle problem, general opposition to industry regulation, distrust of federal regulators precipitated by an effective propaganda campaign from industry organizations, ineffective communication between industry and government regulators, and ineffective technology transfer. In 1989 after three years of litigation, industry opposition, political pressure, and aborted attempts to enact regulations, mandatory TED regulations became effective. Effective widespread implementation of TED technology required intensive enforcement efforts which included criminal as well as civil prosecution, fines, and catch seizures. Widespread use of TEDS resulted in identification of operational and technical problems with some designs which combined with poor construction and installation resulted in significant revenue loss for many vessels. Cooperative efforts between fishers and gear technologists which began in earnest in 1990 lead to the identification of and solutions to technical problems and the development of more efficient designs. The improved TED design was a simple grid design constructed from aluminum tubing or pipe which increases strength and durability. The new design (fig. 1) employed a curved bar design which provided improved efficiency , effective floatation, improved angle of attack, effective guiding funnels and exit flaps and improved installation and operating instructions. Effective transfer of technological improvements resulted from intensive technical training of law enforcement officers who were able to advise fishers on technical problems, effective technical manuals and summary placards, and an intensive technical training program for fishers which included an effective multimedia training presentation and hands on demonstrations by gear technologists. Cooperation between fishers and gear technologist resulted in efficient and effective technological improvements, better communication, a more effective technology transfer program, compliance with mandatory regulations, recovery of threatened and endangered sea turtle species, and sustainability of the valuable penaied shrimp fishery.

Development and Introduction of Bycatch Reduction Devices (BRDs)

In 1990 amendments to the Magnuson Fishery and Management Act (Public Law 101-27) required the U.S. Secretary of Commerce to conduct a 3 year research program to determine the impact of shrimp trawl bycatch on federally managed fishery resources. The amendments also required the secretary to establish a cooperative program to design and evaluate approaches for reducing the mortality of incidentally harvested fishery resources. A comprehensive approach was taken in planning and implementation of a regional bycatch research program which had the advantage of experience gained from TED development and implementation. In 1991 the National Marine Fisheries Service's Southeast Regional Office and Fisheries Science Center developed and published a document entitled "Shrimp Trawl Bycatch Research Requirements (NMFS, 1991). This document established research protocols based on proven scientific methods which were subjected to peer review by an industry-organized panel of researchers and

statisticians. To insure effective communication and participation of all affected parties the NMFS established cooperative agreements with The Gulf and South Atlantic Fisheries Development Foundation, a non profit industry organization, to organize a Finfish Bycatch Steering committee to guide the development and implementation of the bycatch research plan. The steering committee included representatives of the commercial and sport fishing industries, conservation organizations, state fishery management agencies, fishery commissions, management councils, universities, and state and federal fishery research agencies. A Technical Review Panel and Gear Review Panel were also established to advise the Steering committee. Working together they developed a research plan addressing finfish bycatch in the Gulf of Mexico and South Atlantic shrimp fisheries (Hoar et al, 1992). Key components of the plan included; cooperative efforts between shrimp fishery, states, universities, conservation groups, and the federal government, strict adherence to stringent scientific protocols, and concurrent social and economic impact studies. One of the objectives of the bycatch research program was to identify, develop, and evaluate gear options for reducing bycatch in the Gulf and South Atlantic shrimp fisheries. The gear review panel was responsible for selecting the best prototype gear modifications for commercial evaluations, monitoring testing in different shrimping areas, and prioritizing gear modifications options for management consideration. The goal of the gear development project was to develop shrimp trawl gear modifications and or fishing tactics capable or reducing the bycatch of finfish with minimum loss of shrimp production. The research plan identified a four phase gear development plan which included:

1. **Initial Design and Prototype Development** - The full technical range of trawl design and modification approaches were identified. Industry techniques, ideas solicited from fishermen, net shops designs, and research studies conducted by various research groups were evaluated. Fish behavior, gear instrumentation, and gear performance studies were conducted on each design using SCUBA, , remote video cameras, and other techniques. This work evaluated fish behavior and feasibility of prototype concepts. The results of this phase were subjectively evaluated based on the experience and expertise of the gear designer and research team. Operational data was taken on the modified net, and preliminary catch performance data obtained during comparative gear trials. The second phase of development was initiated once a design was determined to offer bycatch reduction potential and integrated into the construction of a net.

2. **Proof of concept** - Objectives during this phase were to evaluate prototype devices on key species, determine total finfish reduction rates, and establish shrimp catch rates. Proof of concept testing evaluated adequacy of design for safety and for problems with operational use. Proof of concept testing was conducted under a specific scientific protocol developed under the "Shrimp Trawl Bycatch Research Requirements" (NMFS, 1991). The most successful designs were prioritized based on proportional bycatch reduction and shrimp retention and reviewed by a technical review panel for inclusion in operational evaluation by the commercial shrimping industry throughout the Southeast.

3. **Operational evaluation** - The objective in this phase was to test the BRD/TED gear combination against a standard TED net under conditions encountered during commercial shrimping operations. Trained observers were placed aboard cooperating commercial vessels to collect data on both shrimp and finfish catch rates as well as species composition. BRD/TED combinations were tested on trawlers using the same TED employed in both the test and control

gear. Testing was conducted over a wide range of geographic areas, seasons, and conditions.

4. **Industry evaluation** - Widespread commercial evaluations of approved BRD designs.

One hundred and forty five (145) gear modifications were evaluated by commercial fishers, state and federal research agencies, and universities under the regional program between 1992 and 1996. Bycatch reduction device designs tested under the regional bycatch program were described by Watson et al, 1993. Proof of concept testing was conducted for twenty one designs approved by the gear review panel and operational evaluations were completed for four designs. Operational testing was conducted in the Gulf of Mexico and South Atlantic and an extensive data base consisting of over 3,400 tows was compiled under the regional program. The results of analyses of these data was reported by Watson et al, 1997 and Branstetter, 1997. The results of the regional bycatch program has been the successful development and testing of shrimp trawling gear modifications capable of producing significant reductions in finfish bycatch with minimum reduction in shrimp catch rates. The most effective designs include the "fisheye" BRD (fig.2) which a simple metal cone shaped device inserted into the trawl codend creating an escape opening and the expanded mesh BRD (fig, 3) which consists of a large square mesh section and a small mesh funnel inside of the square mesh. The expanded mesh BRD is installed between the TED and the trawl codend. This technology has been successfully implemented in all state and federal waters in the U.S. South Atlantic and is proposed for implementation in the Gulf of Mexico in January, 1998.

These two examples of the introduction and acceptance of new sustainable technologies demonstrate different approaches which can be effective in developing and implementing technologies which are more acceptable to users. Important points to be considered include:

- Voluntary acceptance of new sustainable technologies may be difficult without financial or other incentives.

- Technologies which result in increase costs and or loss of revenue will likely be resisted by users.

- User groups should be active participants in every aspect of planning, development, and evaluation of new technologies.

- Mandatory use of new sustainable technologies requires effective enforcement commitment.

- Technical training of enforcement personnel can be a cost effective technology transfer technique.

- Planning for new technology development should include major commitment for technology transfer activities.

- Regulations implementing new sustainable technologies should be flexible and easily modified to allow modifications necessary to adapt gear to different conditions

encountered during commercial operations and to allow for technological improvements.

- Successful development and acceptance of sustainable technologies requires effective communication and cooperation between users and fishery researchers and regulators.

DISCUSSION POINTS

1. Techniques which can be used to encourage effective communication and cooperation between user groups and fishery researchers and regulators involved in development and implementation of new sustainable technologies.

2. Incentives for user groups to voluntarily implement sustainable technologies.

3. Factors which may affect management decisions to implement new technologies through voluntary or mandatory means.

4. Utilizing enforcement personnel as resource to assist in transfer of sustainable technologies.

REFERENCES

Branstetter, S., Bycatch and its reduction in the Gulf of Mexico and South Atlantic Shrimp fisheries. 1997. Gulf and South Atlantic Fisheries Development Foundation, Inc. Suite 997, Lincoln Center, 5401 West Kennedy Boulevard, Tampa Florida 33609.

Broadhurst, M.K, Kennelly, S.J., Watson, J.W. and I.K. Workman. 1996. Evaluations of the Nordmore-grid and secondary by-catch reducing devices (BRDs) in the Hunter River prawn-trawl, Australia. Fishery Bulletin (in press).

Goodyear, C.P.,1990. Status of red snapper stocks in the Gulf of Mexico. USDOC, NMFS, SEFC, Miami Laboratory Contribution CRD 89/90-05.

Hillestad, H.O., Richardson, J. I., McVea, C. and J.W. Watson. 1979. Worldwide incidental capture of sea turtles. World Conference on Sea Turtle Conservation. Nov. 1979.

Hoar, P., J Hoey, and J. Nance (eds.), 1992. A research plan addressing finfish bycatch the Gulf of Mexico and South Atlantic shrimp fisheries. Tampa, Florida, 114 pp.

Mitchell, J.F., Lohoefener, R. and J.W. Watson. 1989. A method for evaluating the exclusion of juvenile sea turtles from turtle excluder devices (TEDS). Ninth Annual Workshop on Sea Turtle Conservation and Biology, Jekyll Island, GA, February 1989.

Mitchell, J.F., Watson, J.W., Seidel, W.R. and A. Shah. 1990. An alternate protocol for the qualification of new turtle excluder devices. Proc. 10th Annual Workshop Sea Turtles Conser. Biol. NOAA Tech. Mem. NMFS-SEFC. 1990.

Mitchell, J.F., Watson, J.W., Foster, D. and R. Caylor. 1995. The turtle excluder device (TED): A guide to better performance. NOAA Tech. Mem. NMFS-SEFSC-366. 33 pp.

National Academy of Sciences, National Research Council, 1990. Decline of the sea turtles: causes and prevention. Washington, D.C. National Academy Press. 189 pp.

National Marine Fisheries Service. 1991. Shrimp trawl bycatch research requirements. NMFS Southeast Regional Office, St. Petersburg, Florida, 66 pp.

National Marine Fisheries Service Southeast Fisheries Center. 1992. Evaluation of bycatch reduction devices sampling protocol manual for data collection. Galveston Laboratory, 62 pp.

Nichols, S., A. Shah, G. Pellegrin, Jr., and K. Mullin. 1990. Updated estimates of annual shrimp fleet bycatch in the offshore waters of the Gulf of Mexico. NMFS, Southeast Fisheries Science Center, Pascagoula Laboratory, 25 pp.

Nichols, S., J. Nance, C.P. Goodyear, A. Shah, and J. Watson. 1995. Some considerations in

determining bycatch reduction requirements. NMFS Mississippi Laboratories. P.O. Drawer 1207, Pascagoula, MS 39568-1207.

Ogren, L.H., Watson, J.W. and D.A.Wickham. 1977. Loggerhead sea turtles (Caretta caretta) encountering shrimp trawls. Mar. Fish. Rev. 1270, Vol 39, No.11, pp15-17.

Powers, J.E., C.P. Goodyear, and G.P. Scott. 1987. The potential effect of shrimp fleet bycatch on fisheries production of selected fish stocks in the Gulf of Mexico. NMFS Southeast Fisheries Science Center Contribution No. CRD87/88-06, 7 pp.

Seidel, W.R. and J.W. Watson. 1978. A trawl design: employing electricity to selectively capture shrimp. Mar. Fish. Rev. 1325 Vol 40, No. 9, pp 21-23.

Watson, J.W. and C. McVea. 1977. Development of a selective shrimp trawl for the southeast ern United States penaeid shrimp fisheries. Mar. Fish. Rev. 1267 Vol. 39, No.10, pp 18-24.

Watson, J.W. and W.R. Seidel. 1980. Evaluation of techniques to decrease sea turtle mortalities in the southeastern United States shrimp fishery. ICES CM. 1980/B:31.

Watson, J.W. 1982. Construction, installation and handling procedures for the National Marine Fisheries Services's sea turtle excluder device. NOAA Technical Memorandum, NMFS-SEFC-71.

Watson, J.W. Mitchell, J.F. and A.K. Shah. 1986. Trawling Efficiency device, a new concept for selective shrimp trawling gear. Mar. Fish. Rev. 48(1).

Watson, J.W. and C.W. Taylor. 1986. Research on selective shrimp trawl designs for penaeid shrimp in the United States. FAO expert consultation on selective shrimp trawl development. Mazatlan, Mexico, Nov. 1986.

Watson, J.W. 1988. Southeast TED Experience. Conference Proceedings. Gear Selectivity as a Management Tool. MIT Sea Grant Publication MITSG-86-18, 57 p.

Watson, J.W. 1989. Fish behavior and trawl design: Potential for selective trawl development. World Symposium on Fishing Gear and Fishing Vessel Design Proceedings. Marine Institute, St. John's, Newfoundland, Canada.

Watson, J.W. and C. W. Taylor. 1990. Research on selective shrimp trawl designs for penaid shrimp in the United States. Proceedings of the Fisheries Conservation Engineering Workshop. Apr. 1990, Rhode Island Sea Grant, Univ. of Rhode Island Publication NO. P1202.

Watson, J.W., Workman, I.K. and B.D. Hataway. 1992. The behavior of fish and shrimp encountering trawls in the Southeastern U.S. penaeid shrimp fishery. MTS '92 Proceedings,

October 19-21, Washington D.C. pp. 336-341.

Watson, J.W. 1992. Status of knowledge in the United States relating fish behavior to the reduction of bycatch. Proceedings of the International Conference on Bycatch in the Shrimp Industry. May 24 -27, Lake Buena Vista, FL. Southeastern Fisheries Assoc.

Watson, J.W. 1992. Trawl gear modifications to reduce bycatch in the Southeastern United states shrimp fishery. MTS '92. Proceedings, October, 19-21, Washington D.C.

Watson, J.W., Workman, I.K., Foster, D., Taylor, C.W., Shah, A., Barbour, J. and D. Hataway. 1993. Status report on the potential of gear modifications to reduce finfish bycatch in shrimp trawls in the Southeastern United States. NOAA Technical Memorandum, NMFS-SEFC-327, 131 pp.

Watson, J.W. 1995. A Cooperative research program addressing finfish bycatch in the Gulf of Mexico and South Atlantic shrimp fishery. Proceedings of Bycatch Conference, University of Rhode Island, April, 1995. (In Press).

Watson, J., A. Shah, S. Nichols, and D. Foster. 1997. Bycatch reduction estimates for selected species in the Gulf of Mexico for bycatch reduction devices evaluated under the regional bycatch program. NMFS Mississippi Laboratories. P.O. Drawer 1207, Pascagoula, MS 39568-1207.

Wickham, D.A. and J W. Watson. 1976. Scuba diving methods for fishing systems evaluation. Mar. Fish. Rev.1192 Vol. 38, No.7. pp15-23.

Workman, I.K., Watson, J.W. and J.F. Mitchell. 1986. Underwater methods and equipment used by fishing gear researchers in the southeastern United States to study and evaluate trawling gear. FAO expert consultation on selective shrimp trawl development. Mazatlan, Mexico, Nov. 1986.

PAPERS AND ARTICLES ON TED DEVELOPMENT AND IMPLEMENTATION
Available from the National Marine Fisheries Service, Harvesting Systems Branch
P.O. Drawer 1207, Pascagoula, MS 39568-1207

Article #	Date	Title	Publication
1	1980	Evaluation of Techniques to Decrease Sea Turtle Mortalities in the Southeastern U.S. Shrimp Fishery	International Council for the Exploration of the Sea
2	1986	Sea Turtles and Shrimp Trawlers	Center for Marine Conservation
3	1989	Shrimpers and lawmakers collide over a move to save sea turtles	unknown
4	1984	Shrimpers can reduce bycatch levels with trawling device	National Fisherman
5	1986	Requiem for TED	Texas Shores
6	1987	Optional Becomes Mandatory	Georgia DNR Outdoor Report
7	Oct. 1989	Gulf Shrimpers Attack TEDs	National Fisherman
8	Feb. 1990	Shrimpers file federal suit against TEDs	New Orleans, Times-Picayune
9	Mar. 1987	House panel votes to delay TED implementation	New Orleans (AP)
10	Jul 1989	Florida fights for TEDs despite delay of U.S. rules	St. Petersburg Times
11	Nov. 1989	How did the shrimping industry get TEDs?	National Fisherman
12	March, 1987	5,000 hear vows to fight TEDs	Houma Daily Courier Houma, LA
13	Aug. 1989	TED observer program turns up wide variation in shrimp losses	National Fisherman
14	1989	House OKS protection of species (even turtles)	BioScience
15	Sep. 1992	Loss of Shrimp by TEDs in coastal waters of the U.S., North Carolina to Texas: March 1988-August 1990	Fishery Bulletin
16	April 1992	The TED experience: Claims and Reality	Center for Marine Conservation
17	Nov. 1990	Super Shooters Pass Test	North Carolina Marine Fisheries News Release

PAPERS AND ARTICLES ON TED DEVELOPMENT AND IMPLEMENTATION

Article #	Date	Title	Publication
18	Nov. 1990	TEDs for particular bottom areas	The Eastern Weekly Moorehead City, NC
19	June 1990	Review of the National Academy of Science Report: Decline of the Sea Turtles	Federal Register
20	Dec 1995	Effects of TEDs on Loggerhead Sea Turtle Strandings with Implications for Conservation	Copeia
21	May 1996	Net Gain: TED use at all time high	U.S. Coast Guard Bulletin