EXHIBIT A

1986 Amendment

Pars. (12) to (15). Pub.L. 99-659, § 111(a), added pars. (12) to (15).

Legislative History

For legislative history and purpose of Pub.L. 99-659, see 1986 U.S.Code Cong. and Adm. News, p. 6240; Pub.L. 104-297, see 1996 U.S. Code Cong. and Adm. News, p. 4073.

§ 1883. Gulf of Mexico red snapper research

(a) Independent peer review

(1) Within 30 days of October 11, 1996, the Secretary shall initiate an independent peer review to evaluate—

(A) the accuracy and adequacy of fishery statistics used by the Secretary for the red snapper fishery in the Gulf of Mexico to account for all commercial, recreational, and charter fishing harvests and fishing effort on the stock;

(B) the appropriateness of the scientific methods, information, and models used by the Secretary to assess the status and trends of the Gulf of Mexico red snapper stock and as the basis for the fishery management plan for the Gulf of Mexico red snapper fishery;

(C) the appropriateness and adequacy of the management measures in the fishery management plan for red snapper in the Gulf of Mexico for conserving and managing the red snapper fishery under this chapter; and

(D) the costs and benefits of all reasonable alternatives to an individual fishing quota program for the red snapper fishery in the Gulf of Mexico.

(2) The Secretary shall ensure that commercial, recreational, and charter fishermen in the red snapper fishery in the Gulf of Mexico are provided an opportunity to—

(A) participate in the peer review under this subsection; and

(B) provide information to the Secretary concerning the review of fishery statistics under this subsection without being subject to penalty under this chapter or other applicable law for any past violation of a requirement to report such information to the Secretary.

(3) The Secretary shall submit a detailed written report on the findings of the peer review conducted under this subsection to the Gulf Council no later than one year after October 11, 1996.

(b) Prohibition

In addition to the restrictions under section 1853(d)(1)(A) of this title, the Gulf Council may not, prior to October 1, 2000, undertake or continue the preparation of any fishery management plan, plan amendment or regulation under this chapter for the Gulf of Mexico commercial red snapper fishery that creates an individual fishing quota program or that authorizes the consolidation of licenses, permits, or endorsements that result in different trip limits for vessels in the same class.

(c) Referendum

(1) On or after October 1, 2000, the Gulf Council may prepare and submit a fishery management plan, plan amendment, or regulation for the Gulf of Mexico commercial red snapper fishery that creates an individual fishing quota program or that authorizes the consolidation of licenses, permits, or endorsements that result in different trip limits for vessels in the same class, only if the preparation of such plan, amendment, or regulation is approved in a referendum conducted under paragraph (2) and only if the submission to the Secretary of such plan, amendment, or regulation is approved in a subsequent referendum conducted under paragraph (2).

(2) The Secretary, at the request of the Gulf Council, shall conduct referendums under this subsection. Only a person who held an annual vessel permit with a red snapper endorsement for such permit on September 1, 1996 (or any person to whom such permit with such endorsement was transferred after such date) and vessel captains who harvested red snapper in a commercial fishery using such endorsement in each red snapper fishing season occurring between January 1, 1993, and such date may vote in a referendum under this subsection. The referendum shall be decided by a majority of the votes cast. The Secretary shall develop a formula to weigh votes based on the

proportional harvest under each such permit and endorsement and by each such captain in the fishery between January 1, 1993, and September 1, 1996. Prior to each referendum, the Secretary, in consultation with the Council, shall—

(A) identify and notify all such persons holding permits with red snapper endorsements and all such vessel captains; and

(B) make available to all such persons and vessel captains information about the schedule, procedures, and eligibility requirements for the referendum and the proposed individual fishing quota program.

(d) Catch limits

Any fishery management plan, plan amendment, or regulation submitted by the Gulf Council for the red snapper fishery after October 11, 1996 shall contain conservation and management measures that—

(1) establish separate quotas for recreational fishing (which, for the purposes of this subsection shall include charter fishing) and commercial fishing that, when reached, result in a prohibition on the retention of fish caught during recreational fishing and commercial fishing, respectively, for the remainder of the fishing year; and

(2) ensure that such quotas reflect allocations among such sectors and do not reflect any harvests in excess of such allocations.".

(Pub.L. 94–265, Title IV, § 407, as added Pub.L. 104–297, Title II, § 207(b), Oct. 11, 1996, 110 Stat. 3612.)

HISTORICAL AND STATUTORY NOTES

References in Text

This chapter, referred to in text, read in the original "this Act", meaning Pub.L. 94–265, Apr. 13, 1976, 90 Stat. 331, as amended, known as the Magnuson–Stevens Fishery Conservation and Management Act, which is classified principally to this chapter. For complete classification of this Act to the Code, see Short Title note set out under section 1801 of this title and Tables.

Legislative History

For legislative history and purpose of Pub.L. 104–297, see 1996 U.S. Code Cong. and Adm. News, p. 4073.

CHAPTER 39—MINING ACTIVITY WITHIN NATIONAL PARK SYSTEM AREAS

§ 1901. Congressional findings and declaration of policy

HISTORICAL AND STATUTORY NOTES

Short Title

Pub.L. 94–429, which enacted this chapter, amended sections 123 and 450y–2 of this title, and repealed sections 350a, 447, and 450z of this title, is popularly known as the "Mining in the Parks Act".

CROSS REFERENCES

Mineral Lands and Regulations—
Adverse affect of acquisition, see 16 USCA § 410aaa–59.
Mojave National Preserve, see 16 USCA § 410aaa–57.

NOTES OF DECISIONS

Repeal 1

1. Repeal

Congress did not impliedly repeal the Secretary of Interior's traditional power to contest validity of unpatented mining claims through passage of Mining in the Parks Act [16 U.S.C.A. §§ 1901–1912]. Alaska Limestone Corp. v. Hodel, D.C.Alaska 1985, 614 F.Supp. 642.

§ 1907. Recordation of mining claims; publication of notice

NOTES OF DECISIONS

Judicial review 1

1. Judicial review

Failure of owner and lessee of unpatented placer mining claims to file timely appeal with Interior Board of Land Appeals from decision

be presumed to have been harvested from the South Atlantic EEZ unless accompanied by documentation that it was harvested from other than the South Atlantic EEZ.

(3) A wreckfish may be offloaded from a fishing vessel only between 8 a.m. and 5 p.m., local time.

(4) If a wreckfish is to be offloaded at a location other than a fixed facility of a dealer who holds a dealer permit for wreckfish, as required under § 622.4(a)(4), the wreckfish shareholder or the vessel operator must advise the NMFS, Office of Enforcement, Southeast Region, St. Petersburg, FL, by telephone (1-800-853-1964), of the location not less than 24 hours prior to offloading.

§ 622.16 Red snapper individual transferable quota (ITQ) system.

The ITQ system established by this section will remain in effect through March 31, 2000, during which time NMFS and the GMFMC will evaluate the effectiveness of the system. Based on the evaluation, the system may be modified, extended, or terminated.

(a) *Percentage shares.* (1) Initial percentage shares of the annual quota of red snapper are assigned to persons in accordance with the procedure specified in Amendment 8 to the Fishery Management Plan for the Reef Fish Fishery of the Gulf of Mexico (FMP) and in paragraphs (c)(1) through (c)(4) of this section. Each person is notified by the RD of his or her initial percentage shares. If additional shares become available to NMFS, such as by forfeiture pursuant to subpart F of 15 CFR part 904 for rule violations, such shares will be proportionately reissued to shareholders based on their shares as of November 1, after the additional shares become available. If NMFS is required to issue additional shares, such as may be required in the resolution of disputes, existing shares will be proportionately reduced. This reduction of shares will be based on shares as of November 1 after the required addition of shares.

(2) All or a portion of a person's percentage shares may be transferred to another person who is a U.S. citizen or permanent resident alien. (See paragraph (c)(5) of this section for restrictions on the transfer of shares in the initial months under the ITQ system.) Transfer of shares must be reported on a form available from the RD. The RD will confirm, in writing, the registration of each transfer. The effective date of each transfer is the confirmation date provided by the RD. The confirmation of registration date will normally be not later than 3 working days after receipt of a properly completed transfer form. However, reports of share transfers received by the RD from November 1 through December 31 will not be recorded or confirmed until after January 1. A fee is charged for each transfer of percentage shares. The amount of the fee is calculated in accordance with the procedures of the NOAA Finance Handbook for determining the administrative costs of each special product or service provided by NOAA to non-Federal recipients. The fee may not exceed such costs and is specified with each transfer form. The appropriate fee must accompany each transfer form.

(3) On or about January 1 each year, the RD will provide each red snapper shareholder with a list of all red snapper shareholders and their percentage shares, reflecting share transfers as indicated on properly completed transfer forms received through October 31. Updated lists may be obtained at other times, and by persons who are not red snapper shareholders, by written request to the RD.

(b) *ITQs.* (1) Annually, as soon after November 15 as the following year's red snapper quota is established, the RD will calculate each red snapper shareholder's ITQ in terms of eviscerated weight. Each ITQ is the product of the red snapper quota, in round weight, for the ensuing fishing year, the factor for converting round weight to eviscerated weight, and each red snapper shareholder's percentage share, reflecting share transfers reported on forms received by the RD through October 31.

(2) The RD will provide each red snapper shareholder with ITQ coupons in various denominations, the total of which equals his or her ITQ, and a copy of the calculations used in determining his or her ITQ. Each coupon will be coded to indicate the initial recipient.

(3) An ITQ coupon may be transferred. If the transfer is by sale, the seller must enter the sale price on the coupon.

(4) Except when the red snapper bag limit applies, red snapper in or from the EEZ or on board a vessel that has been issued a commercial permit for Gulf reef fish, as required under §622.4(a)(2)(v), may not be possessed in an amount, in eviscerated weight, exceeding the total of ITQ coupons on board. (See §622.39(a) for applicability of the bag limit.)

(5) Prior to termination of a trip, the operator's signature and the date signed must be written in ink on the "Vessel" part of ITQ coupons totaling at least the eviscerated weight of the red snapper on board. An owner or operator of a vessel must separate the "Vessel" part of each such coupon, enter thereon the permit number of the dealer to whom the red snapper are transferred, and submit the "Vessel" parts with the logbook forms for that fishing trip. An owner or operator of a vessel must make available to an authorized officer all ITQ coupons in his or her possession upon request.

(6) Red snapper harvested from the EEZ or possessed by a vessel with a commercial permit for Gulf reef fish, as required under §622.4(a)(2)(v), may be transferred only to a dealer with a Gulf reef fish permit, as required under §622.4(a)(4). The "Fish House" part of each ITQ coupon must be given to such dealer, or the agent or employee of such dealer, in amounts totaling at least the eviscerated weight of the red snapper transferred to that dealer.

(7) A dealer with a Gulf reef fish permit may receive red snapper only from a vessel that has on board a commercial permit for Gulf reef fish. A dealer, or the agent or employee of a dealer, must receive the "Fish House" part of ITQ coupons totaling at least the eviscerated weight of the red snapper received. Immediately upon receipt of red snapper, the dealer, or the agent or employee of the dealer, must enter the permit number of the vessel received from and date and sign each such "Fish House" part. The dealer must submit all such parts as required by paragraph (d)(6) of this section. A dealer, agent, or employee must make available to an authorized officer all ITQ coupons in his or her possession upon request.

(c) *Procedures for implementation*—(1) *Initial shareholders.* The following persons are initial shareholders in the red snapper ITQ system:

(i) Either the owner or operator of a vessel with a valid permit on August 29, 1995, provided such owner or operator had a landing of red snapper during the period 1990 through 1992. If the earned income of an operator was used to qualify for the permit that is valid on August 29, 1995, such operator is the initial shareholder rather than the owner. In the case of an owner, the term "person" includes a corporation or other legal entity; and

(ii) A historical captain. A historical captain means an operator who meets all of the following qualifications:

(A) From November 6, 1989, through 1993, fished solely under verbal or written share agreements with an owner, and such agreements provided for the operator to be responsible for hiring the crew, who was paid from the share under his or her control.

(B) Landed from that vessel at least 5,000 lb (2,268 kg) of red snapper per year in 2 of the 3 years 1990, 1991, and 1992.

(C) Derived more than 50 percent of his or her earned income from commercial fishing, that is, sale of the catch, in each of the years 1989 through 1993.

(D) Landed red snapper prior to November 7, 1989.

(2) *Initial shares.* (i) Initial shares are apportioned to initial shareholders based on each shareholder's average of the top 2 years' landings in 1990, 1991, and 1992. However, no person who is an initial shareholder under paragraph (c)(1) of this section will receive an initial percentage share that will amount to less than 100 lb (45.36 kg), round weight, of red snapper (90 lb (41 kg), eviscerated weight).

(ii) The percentage shares remaining after the minimum shares have been calculated under paragraph (c)(2)(i) of this section are apportioned based on each remaining shareholder's average of the top 2 years' landings in 1990, 1991, and 1992. In a case where a landing is

associated with an owner and a historical captain, such landing is apportioned between the owner and historical captain in accordance with the share agreement in effect at the time of the landing.

(iii) The determinations of landings of red snapper during the period 1990 through 1992 and historical captain status are made in accordance with the data collected under Amendment 9 to the FMP. Those data identify each red snapper landing during the period 1990 through 1992. Each landing is associated with an owner and, when an operator's earned income was used to qualify for the vessel permit at the time of the landing, with such operator. Where appropriate, a landing is also associated with a historical captain. However, a red snapper landings record during that period that is associated solely with an owner may be retained by that owner or transferred as follows:

(A) An owner of a vessel with a valid commercial permit for Gulf reef fish on August 29, 1995, who transferred a vessel permit to another vessel owned by him or her will retain the red snapper landings record for the previous vessel.

(B) An owner of a vessel with a valid commercial permit for Gulf reef fish on August 29, 1995, will retain the landings record of a permitted vessel if the vessel had a change of ownership to another entity without a substantive change in control of the vessel. It will be presumed that there was no substantive change in control of a vessel if a successor in interest received at least a 50 percent interest in the vessel as a result of the change of ownership whether the change of ownership was—

(*1*) From a closely held corporation to its majority shareholder;

(*2*) From an individual who became the majority shareholder of a closely held corporation receiving the vessel;

(*3*) Between closely held corporations with a common majority shareholder; or

(*4*) From one to another of the following: Husband, wife, son, daughter, brother, sister, mother, or father.

(C) In other cases of transfer of a permit through change of ownership of a vessel, an owner of a vessel with a valid commercial permit for Gulf reef fish on August 29, 1995, will receive credit for the landings record of the vessel before his or her ownership only if there is a legally binding agreement for transfer of the landings record.

(iv) Requests for transfers of landings records must be submitted to the RD and must be postmarked not later than December 14, 1995. The RD may require documentation supporting such request. After considering requests for transfers of landings records, the RD will advise each initial shareholder or applicant of his or her tentative allocation of shares.

(3) *Notification of status.* The RD will advise each owner, operator, and historical captain for whom NMFS has a record of a red snapper landing during the period 1990 through 1992, including those who submitted such record under Amendment 9 to the FMP, of his or her tentative status as an initial shareholder and the tentative landings record that will be used to calculate his or her initial share.

(4) *Appeals.* (i) A special advisory panel, appointed by the GMFMC to function as an appeals board, will consider written requests from persons who contest their tentative status as an initial shareholder, including historical captain status, or tentative landings record. In addition to considering written requests, the board may allow personal appearances by such persons before the board.

(ii) The panel is only empowered to consider disputed calculations or determinations based on documentation submitted under Amendment 9 to the FMP regarding landings of red snapper during the period 1990 through 1992, including transfers of such landings records, or regarding historical captain status. In addition, the panel may consider applications and documentation of landings not submitted under Amendment 9 if, in the board's opinion, there is justification for the late application and documentation. The board is not empowered to consider an application from a person who believes he or she should be eligible because of hardship or other factors.

(iii) A written request for consideration by the board must be submitted to the RD, postmarked not later than December 27, 1995, and must contain

documentation supporting the allegations that form the basis for the request.

(iv) The board will meet as necessary to consider each request that is submitted in a timely manner. Members of the appeals board will provide their individual recommendations for each appeal to the GMFMC, which will in turn submit its recommendation to the RD. The board and the GMFMC will recommend whether the eligibility criteria, specified in Amendment 8 to the FMP and paragraphs (c)(1) and (c)(2) of this section, were correctly applied in each case, based solely on the available record including documentation submitted by the applicant. The GMFMC will also base its recommendation on the recommendations of the board. The RD will decide the appeal based on the above criteria and the available record, including documentation submitted by the applicant and the recommendation of the GMFMC. The RD will notify the appellant of his decision and the reason therefor, in writing, normally within 45 days of receiving the GMFMC's recommendation. The RD's decision will constitute the final administrative action by NMFS on an appeal.

(v) Upon completion of the appeal process, the RD will issue share certificates to initial shareholders.

(5) *Transfers of shares.* The following restrictions apply to the transfer of shares:

(i) The transfer of shares is prohibited through September 30, 1996.

(ii) From October 1, 1996, through September 30, 1997, shares may be transferred only to other persons who are initial shareholders and are U.S. citizens or permanent resident aliens.

(d) *Exceptions/additions to general measures.* Other provisions of this part notwithstanding—

(1) Management of the red snapper ITQ system extends to adjoining state waters in the manner stated in paragraphs (d)(2) and (d)(3) of this section.

(2) For a dealer to receive red snapper harvested from state waters adjoining the Gulf EEZ by or possessed on board a vessel with a commercial permit for Gulf reef fish, the dealer permit for Gulf reef fish specified in §622.4(a)(4) must have been issued to the dealer.

(3) A copy of the dealer's permit must accompany each vehicle that is used to pick up from a fishing vessel red snapper from adjoining state waters harvested by or possessed on board a vessel with a commercial permit for Gulf reef fish.

(4) As a condition of a commercial vessel permit for Gulf reef fish, without regard to where red snapper are harvested or possessed, a vessel with such permit must comply with the red snapper ITQ requirements of paragraph (b) of this section; may not transfer or receive red snapper at sea; and must maintain red snapper with head and fins intact through landing, and the exceptions to that requirement contained in §622.38(d) do not apply to red snapper. Red snapper may be eviscerated, gilled, and scaled but must otherwise be maintained in a whole condition.

(5) As a condition of a dealer permit for Gulf reef fish, as required under §622.4(a)(4) or under paragraph (d)(2) of this section, without regard to where red snapper are harvested or possessed, a permitted dealer must comply with the red snapper ITQ requirements of paragraph (b) of this section.

(6) In any month that a red snapper is received, a dealer must submit the report required under §622.5(c)(3)(ii). The "Fish House" parts of red snapper individual transferable coupons, received during the month in accordance with paragraph (b) of this section, must be submitted to the SRD with the report.

(7) It is unlawful for a person to do any of the following:

(i) Receive red snapper from a fishing vessel without a dealer permit for Gulf reef fish.

(ii) Fail to carry a copy of the dealer's permit, as specified in paragraph (d)(3) of this section.

(iii) Fail to comply with a condition of a permit, as specified in paragraph (d)(4) or (d)(5) of this section.

(iv) Fail to report red snapper received, as specified in paragraph (d)(6) of this section.

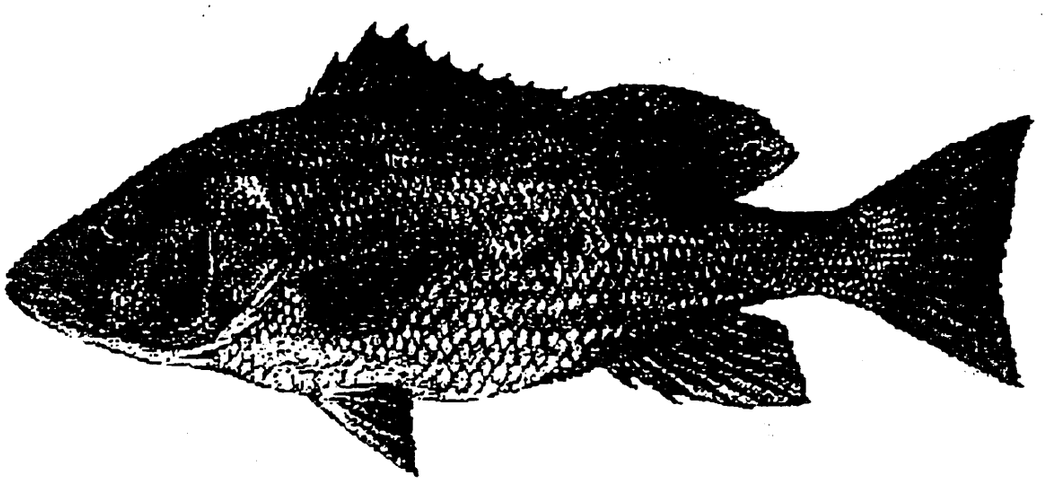
EFFECTIVE DATE NOTE: At 61 FR 48415, Sept. 13, 1996, §622.16 was stayed indefinitely.

§622.17 South Atlantic golden crab controlled access.

(a) *Applicability.* For a person aboard a vessel to fish for golden crab in the

EXHIBIT B

Consolidated Report on the Peer Review of Red Snapper (*Lutjanus campechanus*) Research and Management in the Gulf of Mexico



Prepared by

MRAG Americas Inc.

for

The Office of Science and Technology
National Marine Fisheries Service

December 1997

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1. Background, goals and scope of the reviews

1.1 Introduction

Gulf of Mexico red snapper provide an important fishery resource utilized by a wide variety of user-groups within the southeast United States. As such, the Gulf of Mexico Fishery Management Council (Council) has established a Fishery Management Plan (FMP) to enhance the red snapper resource and restore it to a more optimal potential. The Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Act) requires the Secretary of Commerce to conduct a thorough and independent evaluation of the scientific and management basis for conserving and managing the red snapper fishery in the Gulf of Mexico. Specifically Section 407(a) of the Act required the Secretary to "initiate an independent peer review to evaluate:

> (A) the accuracy and adequacy of fishery statistics used by the Secretary for the red snapper fishery in the Gulf of Mexico to account for all commercial, recreational, and charter fishing harvests and fishing effort on the stock;
>
> (B) the appropriateness of the scientific methods, information, and models used by the Secretary to assess the status and trends of the Gulf of Mexico red snapper stock and as the basis for the fishery management plan for the Gulf of Mexico red snapper fishery;
>
> (C) the appropriateness and adequacy of the management measures in the fishery management plan for red snapper in the Gulf of Mexico for conserving and managing the red snapper fishery under this Act; and
>
> (D) the costs and benefits of all reasonable alternatives to an individual fishing quota program for the red snapper fishery in the Gulf of Mexico."

The Act further required that during the review process that, "commercial, recreational, and charter fishermen in the red snapper fishery in the Gulf of Mexico are provided an opportunity to -- (A) participate in the peer review under this subsection; and (B) provide information to the Secretary concerning the review of fishery statistics under this subsection without being subject to penalty under this Act or other applicable law for any past violation of a requirement to report such information to the Secretary." The Secretary is required to "submit a detailed written report on the findings of the peer review conducted under this subsection to the Gulf Council no later than one year after the date of enactment of the Sustainable Fisheries Act." The Secretary's report to the Gulf Council was due on October 11, 1997.

1.2 A brief history of the fishery and its management

Red snapper have been exploited in the Gulf of Mexico for many decades using a variety of gears. In addition to the commercial fisheries, in the last 20-30 years recreational fishing for red snapper has also developed. Also, trawling by shrimp vessels over the last two or three decades has resulted in a bycatch of red snapper which were discarded dead and which contributed to the overall fishing mortality of red snapper. Landings of red snapper by commercial fishing vessels from 1964 through 1994, estimated recreational harvest from 1979 through 1994, and estimated discards of red snapper by the shrimp trawl fishery in the Gulf of Mexico are illustrated in Figures 1, 2 and 3 respectively.

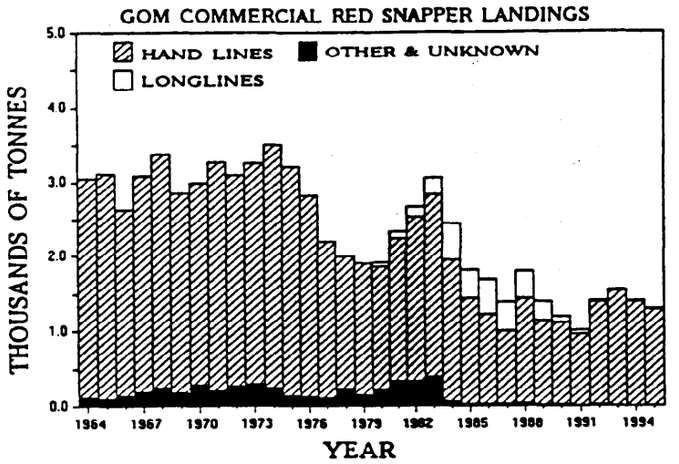

Figure 1. Commercial landings of red snapper from U.S. waters of the Gulf of Mexico (figure 44 from Goodyear 1995).

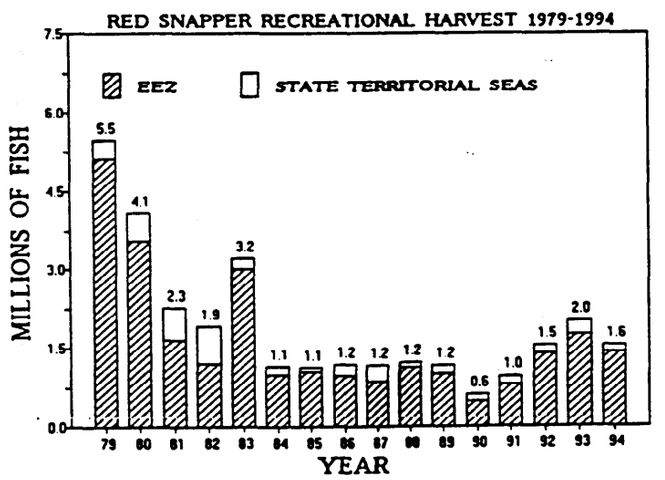

Figure 2. Estimated numbers of red snapper harvested by recreational fishermen, 1979 to 1994 (figure 57 from Goodyear 1995).

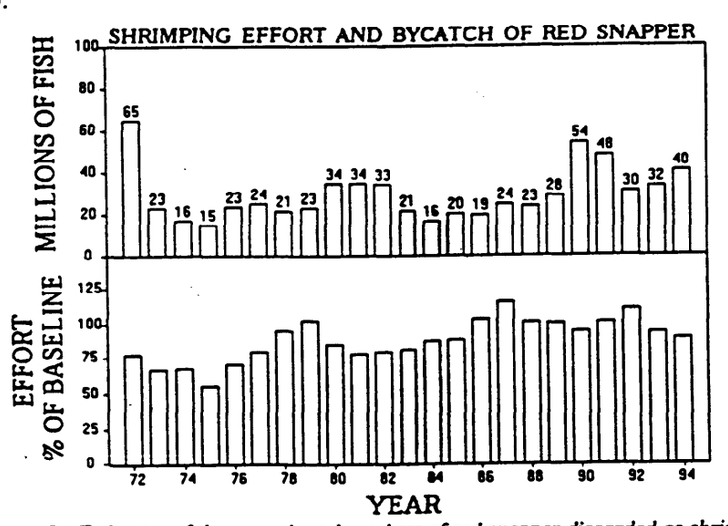

Figure 3. Estimates of the annual total numbers of red snapper discarded as shrimp bycatch and weighted shrimping effort by year (figure 68 from Goodyear 1995)

U.S. Gulf of Mexico red snapper are presently managed under the 1984 Gulf of Mexico Fishery Management Council's Reef Fish Fishery Management Plan (FMP) and subsequent amendments which were designed to provide for further protection for the stock. The Gulf red snapper stock is currently considered to be overfished. This has been attributed to a combination of overexploitation by directed fisheries (commercial and recreational), high bycatch mortality of juvenile fish in the shrimp fishery, and biological characteristics of red snapper, which make it vulnerable to overfishing. A major fisheries management goal of the Council and NMFS is to restore the stock to a non-overfished status. The maximum duration of the recovery period is set by regulation to no more than 1.5 times the unfished generation time, which is itself the consequence of the interactions of growth, mortality and fecundity. To achieve these goals, the Council has implemented a suite of regulations including recreational bag limits, minimum sizes, commercial quotas, commercial trip limits within the open season, special management zones where bag limits and minimum size regulations are more restrictive and permitting systems to restrict new entries into the commercial fishery. While recent studies have indicated that progress has been made in rebuilding the red snapper stock, it is felt that a major impediment to the recovery progress is the impact of shrimp bycatch.

Stock assessment analyses on Gulf of Mexico red snapper have been prepared by NMFS in 1986, 1988, 1990, 1991, 1992, 1993 and 1995. These analyses were reviewed by the Council's Reef Fish Stock Assessment Panel. The Stock Assessment Panel consists of scientists from State agencies, academia and NMFS. Subsequent to the review, the Stock Assessment Panel made recommendations for allowable biological catch (ABC) based upon those analyses, additional analyses conducted at their meetings and the stated goals of the FMP. In turn the analyses and ABC recommendations were reviewed by the Socio-Economic Panel and Scientific and Statistics Committee of the Council were then used as the basis for making total allowable catch (TAC) decisions and to develop a long term management strategy and the regulatory tactics to achieve the management goals.

Additionally, there have been several special scientific review panels which dealt with scientific issues that affect red snapper assessment and management including: bycatch estimation; estimation of shrimping effort used in bycatch estimations; development of observer programs to monitor bycatch; determination of appropriate thresholds defining overfishing; and evaluation of recreational catch estimates.

Nevertheless, a significant amount of controversy remains about the status of Gulf of Mexico red snapper and the appropriate management actions that might need to be taken to rebuild the red snapper stock in the Gulf of Mexico. Typically the controversy has centered around the level of red snapper bycatch being taken and its estimation, particularly in recent years; whether the assessments are accurately characterizing improvements in the stock in recent years and whether regulations are, thus, too restrictive; the possibility that commercial statistics might be under reported in the commercial data series; and the accuracy and precision of recreational estimates, particularly in recent years, which affect both the determination of status of the stock and the allocation between recreational and commercial users.

These issues have led to the Congressional mandate for an independent scientific assessment of the status of red snapper in the Gulf of Mexico and a peer review of the scientific information *in toto*, including the fisheries statistics, the assessments, and the appropriateness of the scientific advice used for management. An independent stock assessment was conducted under contract to National Marine Fisheries Service by a team of scientists headed by Dr. Brian Rothschild at the University of Massachusetts.

Quotas set for the 1993, 1994 and 1995 commercial fishing seasons were filled in 95, 77 and 50 days, respectively. This trend of decreasing fishing seasons emphasizes the need for effort capacity

controls for the commercial fishery. Amendment 8 to the Reef Fish Fishery Management Plan sought to establish a individual transferable quota (ITQ) system for the fishery, however, Congressional constrains have prevented its implementation. Currently fishing effort is limited by requirements for red snapper vessel permit endorsements for fishing vessels participating in the fishery and trip limit system. In addition, NMFS has instituted a moratorium on the issuance of new reef fish commercial vessel permits (except for certain new permits issued through transfers of existing permits) through December 31, 2000.

1.3 The peer reviews

The peer review was divided into three separate reviews according to subject area, each conducted by panels of independent experts. The Statistics Review Panel examined the accuracy, precision and adequacy of the commercial, recreational and charter boat red snapper catch and effort statistics. The Economics Review Panel reviewed the cost-benefit analyses conducted in preparation for Amendment 8 to the Reef Fish Fishery Management Plan, including a review of all reasonable alternatives to an individual fishing quota program for the red snapper fishery in the Gulf of Mexico. The Science and Management Review Panel reviewed the scientific and management basis for managing the red snapper stock in the Gulf of Mexico. In addition, the Science and Management Review Panel reviewed information *in toto* and included a review of the following information:

- reports from the statistics and economic reviews,
- the results from the 1995 assessment;
- the independent assessment conducted at the University of Massachusetts;
- the appropriateness of the scientific methods, information, and models used to assess the status and trends of the red snapper stock; and
- the appropriateness and adequacy of the management measures in the fishery management plan for red snapper for conserving and managing the fishery.

Each review panel met once. The panel meetings were for the presentation of information to the reviewers by scientists, fishery managers, and fishing industry representatives. Reviewers reports were based on their own conclusions and viewpoints. Each reviewer submitted a report independently to the Director of the Office of Science and Technology, National Marine Fisheries Service. A more detailed review of the issues addressed by each of the three reviews is provided in Section 3.

The original plan required each panel to meet for 4 to 5 days. The first half of each meeting consisted of presentations by scientists from NMFS, fishery management agencies, academia, and the fishing industry who had been involved in research or management of red snapper in the Gulf of Mexico or as part of the fishing industry. Industry representatives were also given the opportunity to present material to the reviewers during this time. Individuals who wished to "provide information, ..., concerning the review of fishery statistics,..." as provided for in the Sustainable Fisheries Act were allowed to do so during the Statistics Review. The second half of each meeting was reserved for panel deliberations and preliminary report writing. Following the panel meeting, the panel worked by correspondence. A final report was prepared by each of the reviewers and submitted to the Director of the Office of Science and Technology between 2 and 4 weeks after the conclusion of the review meetings.

An independent contractor was selected to prepare this final consolidated report which incorporates the findings, recommendations and discussions of the reviewers' reports. The reviewers' reports are included in this report in their entirety in Annex I.

4. Consolidation of the reviewers' reports

This section presents a consolidation of the thirteen independent reviewers reports from the three review panel meetings, as described briefly in Section 1.4, and in accordance with the Statement of Work in Annex VIII. The results of the Science and Management Review are presented first, as these represent the major findings and conclusions of the whole review process. As explained in section 3.3, the intention was for conclusions and recommendations from both the Statistics and Economics reviews to be considered by the Science and Management Review Panel. In the event only the reports of the Statistics Panel were available at the time of the Science and Management Panel meeting, and the reports of the Economics Review were not considered by the Panel.

4.1 The Science and Management Review

4.1.1 Outline

The goals and objectives of the Science and Management Review Panel are explained in section 3.3 of this report. Numerous presentations were made to the panel. In addition, extensive briefing, scientific, regulatory and legal documents were provided. The review panel considered fishery independent data, fisheries data, stock assessment results, management advice from the assessments, and the implementation of the advice as reflected in the amendments to the FMP. T. Kevin Stokes (Stokes) describes the process in his report as thorough and open, with considerable input by NMFS personnel, consultants (LGL Ecological Research Associates), academics and the industry.

At the meeting the panel heard presentations from representatives from the NMFS Office of Science and Technology, Gulf of Mexico Fishery Management Council, NMFS (Southeast Regional Office, Beaufort Laboratory, Miami Laboratory, and Pascagoula Laboratory), the Gulf and South Atlantic Fisheries Development Foundation, the University of Massachusetts (Independent Red Snapper Assessment by Rothschild *et al.*), and the Texas Shrimp Association. C. Phillip Goodyear also gave a presentation on the 1995 Red Snapper Assessment (Goodyear, 1995).

Stokes explains that the various people involved in the process were all eager to contribute both during the meetings and during breaks. Alan Sinclair (Sinclair) remarks that the review process is to be commended for being comprehensive, open, and promoting a level of cooperation and data exchange uncommon in fish stock assessments.

Following the formal presentations, Phil Goodyear, Benny Gallaway (representing the Texas Shrimp Association) and Scott Nichols (NMFS Pascagoula Laboratory) provided considerable additional insight, materials and explanations to the panel during its deliberations. Reports from the earlier Statistics Panel were made available to the panel, but, unfortunately, the economics reports were not ready for distribution at the time of the meeting. Hence the Science and Management Review Panel was unable to consider fully the economics issues raised by the earlier meeting.

As with the two following sections, covering the statistics and economics reviews, the structure of this section is designed to provide an accurate and comprehensive consolidation of the individual reports of the five panel members. In most cases the reports include specific responses to the six questions set for the panel in the original Plan for the Peer Reviews (Section 3.3.2), using the questions as section headings. For ease of reference, this structure is used in the following section providing an overview of the responses, where they have been made. Following the responses to the questions, there are four further sections which present information and comments provided by one or more of the panelists which are outside the specific scope of the questions themselves. In cases where a reviewer has not responded on a particular point or question, this should not be construed as tacit

agreement or disagreement with the findings of the other panel members, rather it is simply that on these particular issues, the panelist made no comment.

4.1.2 Specific responses to the questions

Question 1 - Overfishing

Is the available scientific evidence consistent with the conclusion that the red snapper stock in the Gulf of Mexico is biologically overfished as defined in the fishery management plan?

Murdoch McAllister (McAllister) succinctly summarizes the conclusion shared independently by all the panel members, when he states that all scientifically credible assessments of red snapper in the Gulf of Mexico very strongly support the conclusion that this stock is severely overfished. Stokes and Timothy Targett (Targett) explain that the overfishing definition is 20% transitional SPR. Stokes and Jon Sutinen (Sutinen) note that assessments which take account of all sources of catch, regardless of the assumed bycatch estimate or juvenile and adult natural mortality rates, indicate that transitional SPR is in the region of 1%. The most optimistic assessments indicate an overall SPR level in the region of 10%.

Several additional assessments were run by Goodyear during the panel meeting, at the request of the panelists, to examine the effects of a wider variety of assumptions than explored previously , particularly where uncertainty was greatest (see also responses to question 4). Sutinen explains that these re-runs, incorporated lower rates of shrimp bycatch, and higher juvenile and adult natural mortality rates, each of which reduces fishing impacts on SPR. He notes that under such favorable, yet plausible, conditions, the estimate of the current SPR is not above 5% and concludes that no set of plausible parameter values appears capable of raising the SPR above the overfishing level. According to Stokes also it is clear that regardless of the source of the bycatch estimate; regardless of the assumed juvenile natural mortality rates; and regardless of the discard survival values, the overall SPR is very low - well below the overfishing definition of 20% transitional SPR. Stokes further notes that regardless of the assumptions made, overall SPR has shown a gradual downward trend over the last decade.

Both Stokes and Sinclair note that the effects of the two main components of the fishery, by-catch in the shrimp fishery and the targeted fishery on the adults, may be considered independently because of the distinctness of the age groups taken by each. Partial SPR may be estimated for each component, and the combined SPR for the entire fishery is the product of the two components. Stokes attributes the gradual downward trend in SPR primarily to an increasing detrimental effect on the stock due to bycatch, resulting in a reduction in the SPR component by a factor of ½ to ⅓, more than offsetting "improvements" in the commercial component. Sinclair concludes that the current bycatch in the shrimp fishery alone is sufficient to prevent achieving the SPR target. Having considered the various analyses presented at and run during the panel meeting, he further concludes that the stock is biologically overfished and it would appear that closing either component completely would be insufficient to achieve the overfishing and stock rebuilding targets.

McAllister similarly reports that all the scenarios run during the meeting gave very pessimistic estimates of current stock status. In all cases results were as pessimistic or more pessimistic that Goodyear's (1995) findings (i.e., %SPR was less than 1% in all cases in 1992 - the most recent year in which a calculation was possible). Although the analysis undertaken by Rothschild *et al.* (1997) provided

estimates of current %SPR which were much larger than Goodyear's (Goodyear 1995), according to McAllister, this is largely because Rothschild *et al.* (1997) left out discard mortality and bycatch in computing *F*, assumed higher values for *M*, and used a static estimate of %SPR (equation provided in McAllister's report, Annex 1). In addition, McAllister points out that these estimates are likely to be positively biassed relative to transitional SPR and Rothschild *et al.* 's other estimates of stock status (e.g., stock size) using the ADAPT version of Virtual Population Analysis (VPA) could also be overly optimistic for similar reasons. Of the third main set of analyses, McAllister notes that all projections undertaken by Gazey, using the LGL estimates of bycatch and alternative values of *M* for age 0 and 1, indicated that the current status of the population was highly overfished with %SPR in 1997 well below 5%.

Whilst not advocating this as an approach, Sinclair points to the most optimistic and most conservative estimates of fishery wide SPR as evidence that the stock is clearly biologically overfished. The former he calculates to be 9% (35% for the shrimp by-catch times 25% for the adult fisheries) and the latter 0.4% (13% for the shrimp by-catch times 3% for the adult fishery).

Question 2 - Management measures

> *If so, and the management objective is to prevent further overfishing and to promote rebuilding of depleted stocks, are the management measures in Reef Fish Fishery Management Plan appropriate to achieve the objective, or are they too severe or not severe enough?*

In answering this question, the panel members provide two levels of response There are general summary responses, in which they all independently express their concern that to a greater or lesser extent, the management measures on the RFMP are not appropriate to achieve the objective. In all cases the concern is that the measures are not severe enough, and principally that they are not robust to uncertainty. In addition there are more specific responses relating to the management of the directed fishery for red snapper and the control of bycatch in the shrimp fishery, including suggestions for alternative approaches and recommendations for future action. These latter, more detailed responses are presented in sections 4.1.4 (by-catch) and 4.1.6 (management of the directed fishery).

General responses

Sinclair explains that he recommended additional runs of the catch projection simulation using alternative stock recruitment functions to further investigate the conclusion from Goodyear's deterministic simulations that the proposed management plan (a 44% reduction in juvenile red snapper *F* due to by-catch in the shrimp fishery and a TAC of 9.2 million pounds in the directed fishery) may achieve the SPR target in the required time frame (by 2019). However, regardless of the results of these additional simulations, he believes that it is unlikely that the management measures proposed to implement these changes are sufficient to achieve the management objectives.

At the outset, Sutinen writes that he considers that the controls on the directed commercial and recreational fisheries (referring to the TAC and minimum fish size for red snapper) are appropriate, but that the approach used to reduce and control red snapper and other finfish bycatch in the shrimp fishery is not appropriate. However, he later concludes generally that there is a risk that current management measures will not achieve the objectives of prevention of further overfishing and promotion of rebuilding of the stock. Referring to the analyses run during the meeting by Goodyear, Sutinen concludes that, under the plausible conditions assumed in those reruns, only far more severe

restrictions on red snapper mortality would raise SPR to, or above, the target of 20% by 2019. Current measures, he believes, carry too much risk of failing to rebuild the stock.

Targett concludes that the *status quo* (i.e., current management measures), even under varying assumptions of bycatch mortality rate and early mortality rate, will not allow the stock to recover. Consequently, fishing mortality, in his opinion directed and/or bycatch, must be reduced. He concludes from the stock recovery simulations run during the panel meeting, however, that given it is unlikely that bycatch in the shrimp fishery can be eliminated, mortality from both the directed fishery and bycatch will have to be reduced below current levels, to provide for red snapper stock recovery by 2019.

Sinclair also concludes that closing either component of the fishery completely would be insufficient by itself to achieve the stock rebuilding targets. In accordance with this, Stokes stresses throughout his report that an increase in transitional SPR will only be brought about by reducing fishing mortality on both juveniles (the by-catch) and adults (the directed fishery). He explains that the age structure is primarily influenced by action on the spawning component of the stock, which is exploited by the directed fishery, but the material on which that fishery can operate is dependent on the numbers of juveniles that can pass through the gauntlet of the bycatch in the shrimp fishery (which takes upwards of 90% of potential recruits to the commercial fishery). He believes the reduction in juvenile mortality needs to be at least 50% and in this case, the commercial TAC could potentially be as high as 6 million pounds. Lesser reductions in juvenile mortality would require lower commercial TACs. Furthermore, the 6 million pound TAC in the commercial fishery is an upper bound that would reduce depending on the required degree of certainty that SPR will recover to 20% by 2019. He believes, as does Sutinen (see above) that current management plans to reduce juvenile mortality by using BRDs may be insufficient.

McAllister is also of the opinion that the current stock rebuilding plan does not appear to be robust to uncertainty and does not appear to ensure that the stock has a reasonable chance of recovery from its overfished status within the desired period of 1.5 generations, although he concedes that the evaluations carried out to date do not enable him to properly answer this question quantitatively. He notes that a variety of policy projections have been carried out under a variety of assumptions and that some of them indicate that the stock rebuilding target will be achieved, whilst others indicate that there will be no net increase in %SPR over the time period (i.e., up to 2019). McAllister believes he has no basis on which to weight these various trajectories, and it is therefore not possible to evaluate the likelihood that stock rebuilding will occur. However, in his opinion, the finding that some plausible projections suggest that no rebuilding will occur casts reasonable doubt on the effectiveness of the current management regime. He therefore feels unable to conclude from the scientific analyses that the current plan has a reasonable chance of promoting stock rebuilding such that 20%SPR is reached by 2019.

Question 6 - Consistency with the Precautionary Approach

> *Is the current management of red snapper in the Gulf of Mexico and the scientific advice consistent with a precautionary approach to fisheries as expressed in the United Nations Food and Agriculture Organization Code of Conduct for Responsible Fisheries?*

The FAO Code of Conduct sets out principles and international standards of behavior for responsible practices with a view to ensuring the effective conservation, management and development of aquatic living resources, with due respect for the ecosystem and biodiversity. In responding to this question, the panelists have chosen to focus on particular aspects of the FAO Code, which they see as the most applicable in this case. Once again, not all panelists have chosen to comment on all aspects, and where no comment is made, this should not be taken as tacit agreement with the comments of the other panel members.

Management decision processes and management objectives

Stokes believes that in terms of management decision processes and inclusion of interested parties, the management process is consistent with the FAO Code. In his view, the legal framework in the USA (the Magnuson-Stevens Act), and the system of management through the Councils, is reasonably consistent with the principles of Fisheries Management set out in Section 7 of the FAO Code. He believes that the provision of Guidelines by NMFS for defining Optimum Yield (OY) and overfishing attempts to emphasise a practical, scientifically based, support for strategic management. He notes that these Guidelines are the subject of frequent, but thoughtful, review and form the basis for fully fledged management plans as called for in Section 7.3 of the FAO Code.

Stokes does, however, express concern over the specific definitions of OY and overfishing for red snapper (see section 4.1.3 for details). He believes that if the reference points for red snapper are to be set on a single species basis, consideration should be given to raising the OY to 30-35%SPR. He

notes that published studies have indicated that such a level is likely to be closer to MSY for many stocks. Sinclair shares this view. In his experience, SPR in the range of 20% will produce fishing mortalities in excess of that needed to produce MSY. He believes that SPR in the range of 30% to 40% are more likely to produce fishing mortality consistent with MSY. In addition, he notes that it will take much longer for a stock to recover to a state capable of producing MSY if the target fishing mortality is MSY than it will if the fishing mortality is set much less than MSY, for example 0.5 or 0.25 F_{msy}.

McAllister also expresses concern regarding the management objectives. He notes that, as required by the precautionary approach, the regulations include provision for biological reference points for management, and stock conditions and management actions with respect to these reference points. However, he points out that the management regulations ignore empirical uncertainty in the reference points selected. In summary:

- He questions whether 20%SPR is close to the replacement SPR and suggests that the regulations could require a re-evaluation of the appropriateness of the 20%SPR overfishing reference point once more stock recruitment data become available.
- He suggests that the same applies to the suggestion of 30%SPR as OY. In his view this appears to be completely arbitrary and an estimate of MSY, based on S/R observations for red snapper, once more observations become available, seems more appropriate.
- He notes that uncertainty in the 1.5 generation time horizon is also ignored with the adoption of the year 2019 as the target date for stock recovery from the overfished state. He points out that if, for example, the rate of natural mortality is higher than the current assumed value of 0.1, then this date is too distant.

Sutinen comments that whilst the fishery management plan does have a 'stock-specific limit reference point,' (20%SPR), measures have not been taken 'to ensure it not be exceeded' (paragraph 7.5.3.b, FAO Code).

Excess fishing capacity and bycatch

Both Stokes and Sinclair regard excess fishing capacity and other conditions set out in Sections 7.2.2 and 7.2.3 of the Code as a remaining problem for the red snapper and associated fisheries. Sinclair believes that it is clear from the development of the derby fishery that resulted from the imposition of TACs that the fleet capacity far exceeds the resource potential and steps are needed to reduce it.

In Stokes' view, excess capacity in the Gulf of Mexico shrimp fishery, with its associated large bycatch of red snapper and other species, is also a problem which needs to be tackled. He believes that bycatch is the one area in which management which affects red snapper is not yet consistent with the FAO Code. Bycatch of juveniles is a major source of juvenile mortality and has a profound effect on SPR. Although investigations are being undertaken to develop gears which might reduce bycatch rate, he believes there is no evidence that sufficient thought has been given to reducing total bycatch of red snapper and other reef fish. He notes that paragraph 7.2.1g of the Code calls for reductions in catch of non-target species using selective gears, although this is *to the extent practicable*. He believes that the problem of red snapper bycatch is sufficiently large that besides the use of selective gears (BRDs), more direct means of reducing bycatch should be investigated (effort/capacity reduction and or re-location of effort), along with their associated economic implications. In his view, this would be consistent with both Paragraph 7.6.9 of the FAO Code and the recent National Standard Guidelines on National Standard 9 (*Federal Register* Vol. 62 No. 149), which require Councils to prioritize bycatch programs in their fisheries monitoring.

Data collection and scientific input into the management process

Stokes views the apparent general weakness in the quality of the basic data which flow into the assessments and forecasts as perhaps the greatest weakness of the red snapper management process. He notes that this is at odds with the conditions set out in much of Section 7.4 of the FAO Code. Nevertheless, in his view, the science carried out by NMFS for many years has been good, and proper attempts have been made to ensure that science has fed into the decision making process. This is fully in accordance with Para. 7.4.1 of the FAO Code. He also notes that the data gathering schemes set up by NMFS are expensive and extensive, and whilst they could in theory be improved, as suggested by members of the Statistics panel, this would be at great cost. He considers the problem in data collection and consequent data and assessment quality, is that the fisheries themselves are widely distributed and prosecuted by a large group of fishermen switching activities in time and space. In his view, the mixture of small and industrial scale operations and the economically important shrimp and recreational fisheries, conspire to create an exceptionally difficult data collection problem. He therefore suggests that criticism should perhaps be qualified with praise that so much has in fact been achieved.

The Precautionary Approach

The issue that most of the panelists focus on in relation to the FAO Code is the application of the Precautionary Approach to Fisheries (Section 7.5). In particular, Sinclair notes that *The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures* (FAO Code, paragraph 7.5.1). In his view, while there remains considerable uncertainty about the current status of the resource and the expected outcomes of reducing the juvenile by-catch and adult fishing mortality, it is abundantly clear that the stock is seriously overfished. He states that these uncertainties should not be used as a reason for inaction.

Stokes also advocates action on the basis of available information. He notes again the considerable uncertainty in many of the inputs used in the forecasts, but in his view NMFS have attempted to use best estimates which, in all cases, also result in the most cautious forecasts. He suggests that, unless it can be demonstrated that bycatch estimates used by NMFS are too high, or that natural mortality rates are higher than assumed, a precautionary approach demands that the currently used best estimates are the forecast inputs of first choice.

In order to be consistent with paragraph 7.5.2 of the Code, Sinclair believes that more use is needed of the uncertainties in point estimates of stock status and catch projections used as the basis for management decisions. He suggests that the council needs to solicit risk analyses of its decisions and adopt procedures that err on the side of conservation. With respect to risk, Targett believes that the Precautionary Approach would dictate reduction in the fishing mortality (directed and/or bycatch) to achieve the goal of 20%SPR by 2019. Sutinen also believes that more conservative, less risk-prone measures are required. Targett suggests that various options be explored to reduce *F* such that conservative stock recovery projections indicate a high probability of achieving the goal of the fishery management plan. Sinclair also notes that the setting fixed TACs for extended periods of time (15 - 20 years) is not consistent with the Code. In his view, it is important to monitor stock status and adjust TACs accordingly.

Socio-economic conditions

Sutinen notes that the management measures do not take into account the uncertainties relating to socio-economic conditions. He concedes that analyses of socio-economic conditions have been conducted but notes there is little indication that the conditions have been properly considered when formulating management policy. He also notes that the analyses have not characterized the uncertainties relating to the possible socio-economic impacts of the management measures. McAllister concurs with this view, and points out that the regulations appear to create fishing derby conditions and encourage a race to catch the fish, overcapitalisation, and fishing when weather conditions may not be safe.

4.1.3 Objectives of the Reef Fishery Management Plan

At various points in their reports the panel members make comments on not just the conduct and the results of the assessments, but also the actual objectives of the Reef Fishery Management Plan (RFMP). For the most part these comments are relatively brief and are integrated in the responses to the Questions (see in particular responses to question 6). However two panelists, Stokes and McAllister, provided more detailed comments on the definitions and objectives used in the RFMP which fall outside the scope of answers to the questions themselves. These comments are summarised in this section. As before, the fact that other panel members have chosen not to comment in such detail on these issues should not be taken as tacit agreement with the views expressed by Stokes and McAllister.

Stokes notes, for the record, that overfishing for red snapper is defined as harvesting at a rate inconsistent with maintaining, or rebuilding, to a level of 20% transitional SPR. He also notes that, somewhat awkwardly, the definition of OY for red snapper is a harvest rate which maintains at least 20%SPR. These definitions have arisen from published studies which were considered by the NMFS Overfishing Reviews and they have been further commented upon, and reaffirmed, by the Gulf of Mexico SPR Management Strategy Committee (1996). Stokes choses not to question these definitions for this review, but he raises one concern with the definition of OY, which at present does not influence any of the conclusions he reaches in his report. In his view, OY is a "target reference point". The definition of the stock being overfished, however, is a "limit reference point". The former is a point which is aimed at (and which one would expect to over and under shoot with roughly equal probability). The latter is a threshold which one would seek to avoid reaching from above with high probability. If a target is chosen wisely, the threshold should be avoided. From below the threshold (the current state for red snapper), one would seek to reach it with high probability within a reasonable time frame (currently taken as 1.5 generations for red snapper- i.e., by 2019). The current low percentage SPR estimates means that the optimum yield definition requires less than immediate attention at present, particularly given the more immediate concerns over the requirement to more fully account for uncertainty in the assessments. In Stokes' opinion, however, it should, nevertheless, be reconsidered.

McAllister provides detailed comments on the choice of 20%SPR as an overfishing threshold (see his full report in Annex 1 for more details). He notes that recent evaluations of the appropriateness of this target for red snapper in the Gulf of Mexico have supported its application (Anon 1996a; Anon. 1996b). However, in his view there remains considerable uncertainty over whether 20%SPR is an appropriate overfishing reference point for the management of red snapper. He explains that the value of 20% was presumably chosen to reflect the "replacement %SPR" ($\%SPR_{rep}$) (Mace and Sissenwine 1993). $\%SPR_{rep}$ has recently been defined as an overfishing threshold and reference point for fishery management in the US and has been applied in several different FMPs (Anon. 1996a, Anon 1996b).

He goes on to explain briefly the derivation of this threshold, and notes that it appears that $\%SPR_{rep}$ is known only very imprecisely for red snapper and the value of 20%, assumed in the FMP, could be very inaccurate. In his view there does not appear to be much empirical support from other species to suggest that $\%SPR_{rep}$ for red snapper is 20%. The actual value could be quite different. However, he notes that the value chosen appears to be conservative since the S/R line that corresponds to it falls well below all of the S/R observations. Having said that, he comments that the calculation of annual %SPR requires accurate estimates of the various quantities such as *M*, fecundity-at-age, and depending on the measure of SPR, *F* for each of the cohorts present in the fishery. For red snapper, estimates of fecundity-at-age and natural mortality rate and thus fishing mortality rates-at-age are only imprecisely known. Finally he presents a brief comparison of the applicability of different measures of SPR and concludes that the unweighted transitional SPR (used by Goodyear 1995), appears to be the most appropriate type of SPR to apply as an indicator of relative spawning potential and an overfishing definition.

In summary, McAllister believes that the weak empirical basis for defining reference points for fishery management of red snapper based on values for %SPR, will improve as more years of S/R data become available as the red snapper stock rebuilds. He suggests that it would appear appropriate to quantitatively evaluate the relative trade-offs between using an empirical estimate of MSY versus $\%SPR_{rep}$ before one or the other was chosen as a reference point for OY.

4.1.4 Bycatch issues

The issue of bycatch of red snapper in the shrimp fishery and its importance for the assessment has already been raised in relation to answers to the Questions in section 4.1.2. This section provides additional detail included in the panelists reports.

In reiteration, Stokes believes that bycatch undoubtedly has a major impact on the red snapper stock and the estimation of the SPR level. In combination with varying assumptions of juvenile natural mortality, the estimated bycatch levels can have a non-trivial effect on forecast levels of SPR. The bycatch of red snapper is composed of 0 and 1 groups. Estimated fishing mortality rates indicate a loss in the order of 90% of potential recruits to the shrimp fishery. Stokes concludes that the results of deterministic forecasts clearly indicate a need for the best possible characterisation of the mortality caused by shrimp fisheries.

Estimation

Stokes notes the considerable effort that has been expended by NMFS and LGL Ecological Research Associates on deriving bycatch estimates of red snapper in the shrimp fishery. Much of the debate seems to have centred on the choice of an appropriate linear model for analysing the bycatch per unit of effort using a variety of covariates, with or without interactions. He notes that both sets of analyses have been criticised and members of the Statistics panel have made useful suggestions for improvements to the models and for alternative estimation schemes and monitoring programs. Stokes stresses the need to resolve issues relating to existing datasets, for example through agreement on how to pre-process the data, and to institute a well designed bycatch monitoring program for the future. This latter initiative should aim to provide unbiased bycatch estimates with associates variance estimates.

Sinclair also remarks on the problems with the quantification of bycatch. He recommends following up on the two options for achieving more precise and justifiable estimates offered by Kaiser (see section 4.1.7). Despite these problems, he believes, as does McAllister that the level of by-catch is

likely to be of sufficient magnitude to have an important effect on red-snapper productivity, and notwithstanding the difficulty in determining the result of any management action to reduce the by-catch, he believes it is clear that no progress can be made on meeting management objectives if the by-catch is not reduced.

McAllister raises the concern that the estimates of the amount of shrimp fishing effort by location and depth used in the estimation of red snapper bycatch are likely to be biased and imprecise because of non-randomness in the protocol used to sample shrimp fishing vessels for fishing effort and catch. He notes the comment of Fanning (see section 4.1.7) that recommendations of recent reviews of shrimp fishery data collection programs have provided some reasonable suggestions for alternatives including shrimp fishing permits and trip tickets that could help to provide better information on the actual amount of shrimping effort.

Reduction

In Stokes' view, if there are no practical means of reducing bycatch, the major management issue is whether or not to reduce effort in, or even to close, the bycatch fishery. Whilst acknowledging that given the social and economic value of the shrimp fishery, this is presumably politically untenable, he points out that National Standard 9 and the FAO Code of Conduct are clear that bycatch reductions and minimisation of wasteful practices are a priority. He stresses that account needs to be taken not just of red snapper but of the plethora of other bycaught species and potential ecosystem damage. He also specifically points out that any reductions must relate not just to bycatch rate but to total bycatch in the fishery - a function of rate and effort.

Regarding the bycatch reduction target of 44%, McAllister notes that considerable uncertainty in the values for some of the parameters and assumptions used in this evaluation, for example in the rate of natural mortality for age 0 and 1 red snapper, were largely ignored was ignored. Thus, he believes that without further analysis, it is not clear whether the modeled rebuilding consequences of this target of 44% are robust to uncertainty. He also expresses concern over the extent to which the target is achievable with the use of BRDs. He regards this as uncertain mainly because of the use of relatively few replicates and extremely high variability in test results for candidate BRDs, and uncertainty over the extent of effective deployment of these devices once they are certified and required to be used in the shrimp fishery (see comments of Sinclair and Sutinen below). Moreover, in his view, the survival rates of red snapper that encounter and escape from the net is uncertain. He cites a European study (e.g., by Petri Suronen, Director of the Marine Laboratory in Helsinki) which indicates that such survival rates can be quite low.

Sinclair also expresses concern regarding the use of BRDs to solve the bycatch problem. Based on the research results to date, he believes that it is not clear that an effective BRD can be found (i.e., one which can achieve the required reduction in bycatch). Stokes regards the results to date of testing the efficacy of various devices as inconclusive.

Sinclair specifically notes that:

- only 1 BRD has met the selection criteria;
- the sample size for testing is very small;
- the uncertainty associated with their performance is high; and
- the industry is very skeptical that these devices will work and they fear substantial losses of valuable shrimp by using them.

Consequently, he believes that it will be difficult to deploy the BRDs into the fishery and as a result, there is a high probability that the desired reduction will not be achieved. As an alternative, he suggests that it may be necessary to consider indirect or direct restrictions on the shrimp fishery such as imposing a red snapper by-catch quota in the shrimp fishery or restricting shrimp fishing effort.

Stokes notes that, although technical measures may be appealing to managers and to fishermen, bycatch is a product of bycatch rate and effort. He therefore also believes the most direct route to reduction of total bycatch is reduction of effort; either *in toto* or using closures in space and time. In his view, this has the added advantage that effort reduction is more easily regulated, monitored and enforced than continually monitoring the changing effectiveness of technical devices. Having said that, he concedes that if technical bycatch reduction devices can be devised which genuinely reduce bycatch levels by 50% or more in all areas of the red snapper range, and which do not compromise shrimp catch and operating conditions aboard ship, they should of course be used. He warns, however, that their use should be carefully scrutinised and total bycatch will still depend on effort expended, so if total bycatch rather than bycatch rate is to be reduced by 50%, effort in the shrimp fishery must not increase further.

Sutinen specifically cites four main reasons why he believes the proposed bycatch reduction measures are inappropriate, and provides a number of possible solutions:

- The management approach is too focused on a single species, red snapper. An appropriate approach would address all bycatch species. Red snapper is thought to account for less than 1% of the total finfish by-catch, which includes Atlantic croaker, sea trouts, longspine porgy, spot, Gulf butterfish, Atlantic cutlassfish, hardhead catfish, Atlantic bumper, Spanish mackerel, king mackerel and red drum. (Amendment 9 of the FMP for Gulf of Mexico shrimp.)

- The focus on a single technological solution, applied across the board, has a high risk of failure. Fishing is far too complex to expect a single technological device (the BRD) to be the best solution to the bycatch problem. BRDs are unlikely to be appropriate under all circumstances. Other measures in combination with BRDs may improve the effectiveness of bycatch reduction, and achieve the reduction at lower cost to and with wider acceptance among the industry.

- There were indications during the review that the shrimp industry has not been sufficiently involved in finding solutions to the bycatch problem. Management authorities should work closely with the shrimp industry to solve the bycatch problem since it is in the industry's interest to solve the bycatch problem comprehensively (i.e., all bycatch species), and it's in the government's interest to gain widespread acceptance of a solution.

- The onus for controlling bycatch is not properly placed. The onus for controlling bycatch should be shifted entirely to shrimp harvesters. That is, shrimp trawlers should be held responsible for maintaining their bycatch below acceptable levels and proving that they have done so. In exchange, shrimp harvesters should be allowed to use any environmentally sound method for achieving their bycatch limit. An effective way to achieve this shift in onus would be to implement bycatch quotas on the shrimp fishery. Shifting the onus to the industry will provide the incentives to find multiple low-cost ways to reduce bycatch.

Targett also advocates working with the shrimp industry to develop a workable framework for red snapper bycatch reduction. In his view this would include the consideration of alternative options to BRDs (e.g., area and/or time closures and annual bycatch quotas).

With regard to effort reduction, Sutinen notes the analysis by Ward (1997) which shows that a shrimp fishery operating at maximum economic yield would significantly reduce the fleet size and total effort below current levels. He notes that the use of ITQs to achieve Maximum Economic Yield (MEY) in the shrimp fishery has been rejected, but suggests that an alternative approach would be to use individual effort quotas, in which individual fishing units would be allocated a fixed number of days to fish. He envisages that over time the total number of days fished would be reduced to approach MEY and to reduce the bycatch of juvenile snapper (and other bycatch species).

Sutinen cites two examples where bycatch quotas are applied in existing fisheries - the Alaska groundfish fisheries and the Sotia Fundy groundfish fisheries. He suggests experience with these and other examples should be investigated. He explains briefly how bycatch quotas work - very much like a standard total quota - but notes the major difference is that not all of the bycatch is landed. There is therefore a need either for monitoring at-sea using observers and/or, as in Canada, having mandatory landings of all catch. He suggests that If ITQs are eventually implemented in the red snapper fishery, the shrimp fishery with a bycatch quota, could be allowed to acquire quota in a given year in order to meet their shrimp landing goals

In Sinclair's view, whatever management approach is selected, it seems imperative that a permanent fisheries observer program be developed to monitor by-catch in the shrimp fishery. Given that all the fish by-catch is discarded, he sees direct estimation at-sea as the only practical approach to monitoring and estimating its level. He notes that deployment patterns and coverage levels would need to be carefully determined in order that inferences may be made about the overall levels of fish by-catch.

4.1.6 Recommendations for management

The general conclusion, reached independently by all the panel members is that if red snapper is to be recovered to above the overfishing definition of 20%SPR, the fishing mortality rate on both juveniles and adults needs to be reduced. Precise levels of reduction will depend on the degree of certainty required for recovery by the specified date of 2019. The values most commonly referred to in the text of the panelists reports are that if total bycatch can be effectively reduced by 50%, the commercial TAC could be set as high as, but no higher than, 6 million pounds. This level would reduce further in the event that:

- effective bycatch reduction decreases, and
- if full and proper account is taken of estimation errors and uncertainties in critical forecast inputs.

Stokes summarizes some of the problems which potentially undermine the successful management of the red snapper fishery as follows:

- if the large bycatch fishery is effectively open, with excess capacity and less than adequate data collection, the assessments will be substandard;
- if data from Mexican fisheries are missing, the assessments will always be open to criticism; and
- if red snapper catches under reef fish permit are less well recorded, or discard survival rates inaccurate, the assessments may be compromised.

He suggests that the complex, inter-acting fishery system and means of regulation (lack of transferable quotas; producer organizations etc.) perhaps point to the need for consideration of a simpler management regime. In his view, laudable as the single species overfishing definitions are, it may be that a multispecies approach would offer the prospect of simpler, more effective management, with

less need for complex and expensive data collection. Robust and adequate might be better than complicated but fragile.

McAllister summarizes similar problems in his report and adds the following:

- If catch rates rise substantially as the stock rebuilds, it is likely that there will be increased pressure from fishermen for increases in the TAC. It is unclear whether catches can effectively be held down under such a scenario.
- difficulties in keeping track of the sports landings during each season in order to determine when to close the season once the recreational quota has been caught.

Despite the existing prohibition on proposals to implement individual quotas, Stokes recommends that consideration be given to how ITQs might be utilised after 2000 in order to control effort in the bycatch fishery. McAllister also suggests that this would be a more attractive approach to management than the current license system, citing, among others the advantages of alleviation of the derby fishery, avoidance of overcapitalisation and problems of safety.

Sinclair notes that the management plan calls for fixing the adult fishery TAC over a 15-20 year period in order to meet the SPR target for this fishery. He believes, as do other panel members, that fixed catch management plans have several pitfalls and comments that they are not favored in the fisheries management literature. In this case, he envisages the following problems:

- fishers will have to fish harder when stock size is low and less when stock size is high;
- the highest exploitation rates would occur at the lowest stock sizes;
- it will be difficult to restrain fishing effort when stock sizes are high; and
- the projected success of the fixed TAC in achieving the SPR target is largely based on the highly optimistic stock/recruitment function used in the catch projections (as described in his response to question 3).

He strongly recommends an alternative approach, to be investigated through simulations, which would be to determine a target *F* for the adult fishery based on the expected mix of quota sharing between the different fleets (commercial, recreational, etc.) and set annual TACs based on stock assessments. He explains that if improved recruitment is not realized, there is security in not promoting too high a catch. Since SPR depends on fishing mortality, the objective might be achieved at lower risk of stock failure.

Both Stokes and McAllister also comment on the non-feasibility under the current management regime of constant catches as the stock recovers and CPUE increases (see above).

In order to improve the efficiency of dealing with complex management problems that involve more than one species and resource user group, McAllister suggests that the RFFMP could be modified to incorporate more of a systems approach and multispecies approach to dealing with fishery management. For example, as the bycatch problem extends across several commercially and ecologically valuable species, it would seem that the most desirable solutions to the bycatch problem could be found if the problem was considered in total rather than one species of a time. As part of such an approach, McAllister also recommends that the issue of allocation of fish resource across different resource user groups be dealt with more explicitly in Reef Fish Fishery Management Plans to promote and maintain a fair and equitable allocation of the access to resources among the various resource user groups.

In closing, Sutinen comments that it is becoming increasingly evident that a critical necessary condition for successful fishery management is industry support for the program. He provides a summary of evidence supporting this view and suggests ways to obtain industry support for the regulations, including:

- meaningfully involving fishermen in the development and implementation of regulatory policy;
- keeping regulations simple with a clear connection to conservation goals; and
- equal application of regulations and enforcement.

(Sutinen, 1995).

He believes this constitutes an argument for heavily involving shrimp harvesters in the process for finding a solution to their bycatch problem. In his view, if they are not so involved, there is significant risk that the resulting measures will fail.

4.2 The Statistics Review

4.2.1 Outline

The Statistics Review Panel was presented with a package of information on the series of data collection programs used to characterize the total removals of red snapper by fisheries in the Gulf of Mexico. Removals comprise both the targeted catch and incidental bycatch in the shrimp fishery. Data collection and estimation procedures were explained in detail in background material and in presentations during the meeting, providing the panel members with information on which to base their responses to the five questions to be addressed:

1. *Are the designs of the data collection programs appropriate?*
2. *Does the estimation protocol for each program take into account the design aspects of the data collection programs?*
3. *Is sampling level and coverage sufficient to adequately describe the target population?*
4. *Are there identifiable biases in the results of the surveys?*
5. *Is the precision of the estimates appropriately expressed?*

The data collection programs were subdivided into five principal categories. The first four each comprise a number of on-going programs of differing scope and design. The fifth is a collection of special studies, rather than a single program. A brief summary is given below. Additional detail is provided in Annex 1 (Appendix B of Christman 1997)

1. Commercial Red Snapper Fisheries Data Collection Programs

- Total landings census - data collected by port agents from seafood dealers either under Federal (NMFS) or state (in Louisiana and Texas) supervision
- Logbook program for catch and effort data - mandatory since 1992 for all vessels with a federal vessel permit, collected directly from the fishers
- Trip interview program (TIP) - focusing on size composition of the landed catch, data collected by port agents from co-operative fishermen
- Brief commercial observer program in 1995 to study mortality or discarded fish, covering about 20 to 30 vessel trips

2 Recreational Red Snapper Fisheries Data Collection Programs

- Marine Recreational Fishery Statistics Survey (MRFSS) - national (except Texas) telephone and on-site interception survey, covering private/rental, shore based, charter and headboat components in all coastal counties
- Texas Marine Sport Harvest Monitoring Program - analogous to the MRFSS, administered by the Texas Parks and Wildlife Department, in place since 1983
- NMFS Charter boat survey - voluntary (since 1989) logbook program aimed to augment inadequate coverage of charter boats by MRFSS, administered by NMFS Panama City Lab, covers eastern Gulf only
- NMFS Headboat survey - logbook (75% returns) started in 1986, designed as complete census of fishing effort and sample of catch per unit effort collected by port agents, aimed to augment inadequate coverage of headboats by MRFSS, administered by NMFS Beaufort Lab

3. Fishery Independent Data Collection Programs

- Summer South East Area Monitoring Assessment (SEAMAP) - groundfish trawl survey, started in 1982, providing estimates of relative abundance, recruitment patterns and species composition
- NMFS Fall groundfish survey - annual groundfish trawl survey, started in 1972, providing estimates of relative abundance, recruitment patterns and species composition, since 1985 covering the same areas as the SEAMAP survey, adopted formal SEAMAP protocols in 1987

4 Commercial Shrimp Fisheries Data Collection Programs

- General canvas landings program - collection of total landings data collected by port agents from seafood dealers, during monthly visits, under Federal (NMFS) supervision
- Trip Interview Program (TIP) - opportunistic sampling for catch and effort data from individual trips
- Voluntary at-sea observer programs - three conducted in the periods 1972 to 1982, and Regional Bycatch Research Program from 1992, to collect discard data, evaluate post-release mortality, and the performance of BRDs

5. Biological characteristics, morphometrics, fecundity and post release morality

- Morphometric study from Louisiana (Wilson, Render and Neiland 1994)
- Age-Length Study by Panama City, FL Lab (Allyn Johnson, 1996)
- Release Mortality (Cage Studies)
- Release Mortality (Headboat Studies)
- Release Mortality (Commercial hook-and-line Studies of discard fish)

4.2.2 Commercial red snapper fisheries data collection programs

Total landings census (including LA and TX State supervised programs)

Several panel members individually conclude that the commercial landings data represent as complete a census count as possible and that there is little observable bias. Kaiser reports that the primary concern in this program is to ensure that data gathered from seafood dealers by port agents, some under federal supervision and some under state (LA and TX) supervision, are collected and recorded in a consistent manner. Mary Christman (Christman) suggests the following actions would make the program more consistent:

- ensure that the categories of dealers canvassed in each state (the state-level sampling frames) are consistent, e.g., if restaurant sales are a significant fraction of red snapper landings then all states should include direct restaurant buyers; and
- where possible, standardize the units in which the data are recorded, e.g., gear used is reported once a year in LA and TX although landings are recorded monthly in those same states.

Paul Fanning (Fanning) considers that the primary statistical concern with any census is the likely bias due to undercount, although Christman indicates that any biases which might result from census undercount, or mis-reporting, are un-controllable and non-quantifiable. She suggests, however, that there is a need to determine the portion of landings missed through direct sale to non dealers, i.e., restaurants and consumers. Hayes considers that all sources indicate that the amount of red snapper represented in such sales is negligible. Christman suggests dropping the gear and area reporting requirements from the dealer collected data, because the logbook program (see below) also records this information for each trip by a commercial vessel. However, all members individually mention the

merit in being able to cross reference data from different sources, e.g., between the landings census and the logbooks. In fact Christman specifically recommends that the comparison of landings census and logbook data should be done on a finer scale, for example at state-level, to ensure that there is no consistent pattern of under- or over-reporting within each state.

Logbook program for catch and effort data

Kaiser describes the logbook program, instituted in 1992, as a major step forward in data collection for the directed fishery, presenting an opportunity for a formal stratified sampling program targeted at the commercial fishery, with the potential to be developed into a major information source. Fanning reports that the possibility of deliberate under-reporting and non-reporting by the fishers exists as a potential bias, although the coverage of the fleet is good and should eliminate any census undercount *per se* (i.e., missed trips). Several panel members' reports highlight the problem that the logbook program does not cover non-permit holders, and that hence it is not clear whether it is in fact a census or sampling methodology. Comparison of the landings from logbooks and dealer records for three years showed generally good agreement.

Trip Interview Program (TIP)

The potential biases resulting from the opportunistic or convenience sampling in the Trip Interview Program (TIP) are of concern to all panel members, and most express the opinion that these are non-quantifiable. Hayes believes that there is in fact no evidence for a directional bias and without the legal authority to require fishermen to provide effort information or samples for determining the size composition of the catch, there is probably little that could be done to achieve a truly random sample. He therefore recommends that the current sampling methods be maintained. Christman suggests that, if it is not actually possible to estimate the variability of the TIP data resulting from the sampling design and measurement error, the best approach is to minimize it. She elaborates that it is necessary to ensure, through training programs, that the port agents are aware of the problems that can arise from selectively sampling a subset of the fishermen landing in their region. This would help to make sampling procedure in the TIP as random as possible. Kaiser suggests that sampling for length composition in the TIP could be improved by measuring all the fish in a selected bin or batch. There is also some concern expressed in the panel members' reports that the TIP only provides data on fish brought ashore, rather than on the fish actually caught.

Two approaches to quantifying sources of bias and uncertainty are suggested in the reports. Christman suggests a small pilot study should be undertaken, in which a concerted effort is made to obtain data from a representative sample of vessels to compare with the results of the present data collection protocol. Kaiser recommends a statistical model (multinomial-Dirichlet) for estimation of the distribution of size classes in the commercial catch, which could be used directly to incorporate uncertainty in estimation of this distribution in stock assessment.

Observer program for collection of data on discards

A strong recommendation made independently by all the panel members is that a permanent observer program onboard commercial vessels targeting red snapper be established to provide, *inter alia*, a systematic source of information on discard in the red snapper fishery. Fanning reports that these data are not collected by any routine means at this time. The discard data field was dropped from the logbook in 1996 (due to lack of use) and there is no regular observer program. Present direct estimates

of discard rate are based on data collected during a voluntary at-sea observer program in 1995, designed primarily to study the mortality of released fish. This program covered only about 20 or 30 trips and may not constitute a representative sample of discard rate in the fishery.

Hayes recommends a thorough examination and possible redesign of the at-sea observer program to ensure that sample sizes and sampling coverage are adequate to directly estimate discarding at sea. Besides the collection of discard data, Kaiser lists a number of other potential benefits of such an observer program:

- Sampling for estimation of the size distribution of the commercial catch, rather than the commercial landings could be obtained;
- periodic sampling for reevaluation of age-length and fecundity-length relations could be easily incorporated;
- independent assessment of catch per unit effort and other information could be obtained for assessment of the logbook program, since there would be available a natural pairing of observer and logbook information for trips on which an observer was present;
- by comparison of estimates from observer data and other currently existing programs (e.g., size distributions obtained from the TIP) an estimate of the reliability of cooperation-dependent sampling (i.e., observers) relative to those that are less dependent on cooperation could be obtained; and
- an observer program could allow actual random sampling of trips, at least among the proportion of vessels that cooperate in the program.

Hayes also stresses that continuing to collect information on discarding by the directed red snapper fishery with the at-sea observer program is also critical, given the possibility of changes in commercial fishermen's behavior in response to changes in minimum size or other management measures as identified in the amendments to the current fishery management plan.

4.2.3 Recreational red snapper fisheries data collection programs

Marine Recreational Fisheries Statistical Survey (MRFSS) and Texas Marine Sport Harvest Program

A number of difficulties are discussed in the panel members' reports in relation to the monitoring of recreational fisheries in the Gulf. These include the large number of boats and trips involved, the lack of a consistent Gulf wide permit system or landings reporting requirement and the division of effort amongst charter boats, headboats and individual recreational boats. The MRFSS and Texas Marine Sport Harvest Program are seen as having been developed partly in a response to these problems.

The panel members all individually consider that the MRFSS program is well conceived and well executed. Kaiser describes it as a quality effort to provide solid information about an exceptionally diverse and variable range of human activities that affect the red snapper resource in the Gulf. Similarly, the Texas Marine Sport Harvest program is considered to be well-developed, although designed around survey of access points to the water rather than the population at large. There is also satisfaction expressed in several reports that the program managers continue to consider possible improvements and modifications to their data collection plans.

One of the main concerns with the MRFSS is that it is not well suited to collecting information on variable local fisheries, such as that for red snapper in the Gulf. In order to increase the ability of the MRFSS to characterize the recreational fisheries on a local scale, the sample size would need to be increased. If budgetary considerations preclude such action, then Christman suggests that at least there should be some additional cross-referencing between the results of the MRFSS and other data collection programs. Christman also suggests performing the MRFSS in Texas for a fixed period and comparing the results with the Texas survey.

The precision of MRFSS estimates of catch and effort for the charter and headboat components of the recreational fishery are thought to be poor due to the large proportion of non-coastal and out of state anglers participating in these sectors. Several panel members independently express concern that the use of a 5 year running mean for the ratio of coastal to non-coastal and out of state participants results in a bias in the number of headboat trips. Hayes suggests that the effect of shortening the period of the running mean should be investigated, to guard against possible bias in estimates of effort due to trends over time. With respect to the deletion of some large values in the MRFSS responses, Christman considers that a more appropriate approach would be to present the data and uncertainty both with and without the large values.

In common with the data from the commercial fishery, Kaiser points out that there has been no consideration of uncertainty in the estimates of size frequency obtained from the intercept interview program, and this should be rectified.

Several members of the panel express concern over the way in which the precision of the catch estimate for the Texas Marine Sport Harvest Program is expressed. Christman in particular elaborates on this. The quoted precision is based on summing the variances for average landings in each of the strata (bay system, season, day type and fishing area). This is correct as far as it goes, but what is not given is the estimate of the variance of the within stratum means. Christman explains that these means are products of several random quantities, including relative fishing pressure, percent of landings outside of a certain time window, etc., each with an associated variance. The variances of these adjustment factors have been ignored and certainly contribute to the true variance. She suggests that an effort should be made to incorporate these variances. Hayes proposes the methods of Guthrie *et al.* (1991) or Pollock *et al.* (1994) given the present design of the program.

NMFS charter boat and Headboat programs

NMFS has instituted two programs targeting the charter boat and headboat fleets to mitigate against the lower precision with which the MRFSS monitors these sectors. Several panel members independently conclude that the charter boat mandatory logbook program has been comprehensively undermined by the charter boat operators' refusal to cooperate, and has not provided a viable approach to monitoring the fleet. Hayes recommends that either a study be undertaken to evaluate whether the charter boat survey could be re-designed to provide synoptic estimates of catch, or alternatively resources be applied to improving the MRFSS in charter boat mode. The charter boat survey needs adequate commitment of resources, particularly personnel, including port agents, to make it work more effectively. Fanning considers that the rotating panel approach proposed by NMFS is sound and should provide the required catch rate and catch composition data.

The Southeast Region headboat survey is structured as a mandatory census, but as yet the coverage is incomplete. It is presently estimated that 75% to 90% of effort is reported, depending on the year. Adjustments are made to the data to fill in the gaps, including estimates made by port agents. Hayes reports that data on fishing effort are treated as a census, but there is no estimate of precision

calculated for the point estimates of total catch, derived from samples of catch per unit effort. He concludes that additional resources should be applied to make the census complete.

Kaiser makes a suggestion aimed at improving the provision of information from the charter and headboat fleets. The recreational fishery presents a difficult characterization problem, in part because of inherent differences between individual fishing trips and those taken aboard charter boats and headboats. To try to resolve this problem, the charter and headboat fleets could be considered as components of the commercial fishery, rather than the recreational fishery. Kaiser's view is that such a change in perspective would be more than a mere administrative shift in classification. Past assessment of the charter industry, in particular, has been approached from the viewpoint of gathering information from individual fishermen (i.e., charter boat clients) rather than from charter boats themselves. Charter trips are more similar to very small and heterogeneous commercial trips, and the collection of data and statistical estimation of effort, catch per unit effort, and release fraction could be approached from this perspective. His suggestion also includes the idea that an observer program could be established. In principle, an observer program aboard charter boats could provide much the same information about this segment of the overall fishery as an observer program aboard commercial vessels. In his view, the collection of reliable data from the charter boat fleet will be dependent on incorporation of charter operators in the data collection process, instead of relying on cooperation with a process to which they are external.

4.2.7 Comments and recommendations regarding the estimation of bycatch of red snapper in the commercial shrimp fishery

All the panel members individually conclude that no other single subject under the statistics review has generated as much controversy or as much outside review activity as the bycatch of red snapper in the commercial shrimp fishery. This section is therefore devoted to a consolidation of the panelists' comments and recommendations on this topic. Before discussing their considerations in detail, however, several general issues raised in the reports are mentioned briefly here. These relate to the importance of understanding the role that estimation of bycatch plays in the overall process of making management decisions concerning the red snapper resource.

An important use of bycatch estimation is to provide mortality rate estimates for use in the stock assessment procedure and, in particular, the estimation and prediction of spawning potential ratio (SPR). However, Kaiser suggests that it is not clear whether the crucial aspect of stock assessment

for management decisions relative to the use of bycatch reduction devices (BRDs) is prediction of SPR under various alternative management strategies, or estimation of current SPR. The fact that bycatch mortality involves primarily pre-recruitment aged fish (ages 0 and 1) would appear to accentuate the effect of bycatch mortality rate in the estimation of SPR. That is, it seems that an increase in the rate of mortality for younger fish has a greater impact on estimation of SPR than an equivalent increase in the rate of mortality for older fish. Under current stock assessment procedures, it is not only estimation of the current level of bycatch and current data collection programs that are of concern, but also the estimation of bycatch mortalities in the past and therefore the use of past data. Kaiser notes that herein lies one of the major problems for the assessment, because it is impossible to improve the quality of the past data.

Proper estimation of bycatch is therefore important for providing a scientific basis for management decisions about red snapper in the Gulf of Mexico. Kaiser expresses the opinion that the need to make use of both current and past sources of data in assessing the need for immediate regulations relative to the use of Bycatch Reduction Devices (BRDs) makes it unlikely that those assessments can be based on a statistical estimation of bycatch that can withstand careful scrutiny. He notes that programs designed to provide data that allow a concrete probabilistic formulation of the problem of bycatch estimation have not been instituted until recently, if at all. He considers, therefore, that the issue of statistical estimation of bycatch is one that deserves substantial attention, but that further review of current methods constitutes only a recipe for inaction.

- Data collection and estimation protocol

Total shrimp fishing effort, derived from the shrimp TIP and the landings census, is used in the assessment to expand the estimated bycatch rates of red snapper in the commercial shrimp fishery. The bycatch rate itself is estimated from the fishery independent survey data using a multiplicative model (using GLM) based on the times when both these data and the shrimp effort data are available. The GLM model uses several datasets: the fishery independent data from the groundfish surveys, the bycatch per unit shrimp effort data obtained from the regional bycatch research program, and data from three volunteer observer surveys conducted during 1972-1982. Predictions of bycatch rate are made for all statistical data cells and then the effort associated with the given cell (estimated or imputed) is used to convert the bycatch per unit effort (BPUE) into an estimate of the total amount of red snapper in the shrimp catch. Fanning, and the other panelists, note that no attempt has been made to carry the estimates of precision or bias through the calculation.

- Previous reviews / other models

There have been a large number of previous reviews of the NMFS assessment work carried out on red snapper, which are mentioned in the reports of the panel members. Previous statistical reviews have occurred in 1991 and January 1997. Christman notes that the reports of the members of the January 1997 statistical panel, tasked to review bycatch estimation techniques, provide updates and recommendations for the more recent efforts of modeling the bycatch. Models that have been studied include: using raw means in each of the cells, using the Delta distribution to account for the excessive number of zeros; using various forms of the GLM model with ln(CPUE+c) as the response variable; using various pooling strategies for the strata and using those data in a GLM model; using fish to shrimp ratios as the response variable in a GLM; and, using different datasets in the GLM models for CPUE. She concludes that some form of the GLM model appears to be the currently accepted method for estimating bycatch, but argues that various efforts to pool data in different ways and then use the

results in the GLM model will provide neither any indication of whether the model is correct nor more accurate results. The data base itself is insufficient and pooling will not make it more sufficient.

Hayes also notes that past reviews have considered or suggested the use of the Delta distribution to estimate discard rates and he cautions against the use of this procedure. In his experience, while this method is useful when sample sizes are large, it is not a robust technique when small sample sizes occur in many cells, as is the case here.

- Problems

The problems described in the review panel's reports focus primarily on two issues - data collection programs and estimation protocols.

The key information required to monitor the bycatch is considered by each of the panel members to be at-sea observations of the amount, size and species composition of the both the target catch and bycatch. Observer data are only available for the periods 1972 to 1982 and 1992 to 1996. All the reports indicate that the lack of direct observations during the mid to late 1980's is the most serious hindrance to the estimation of discards. Problems with the observer data themselves are also noted, arising, for example, from the spatial and temporal coverage of the voluntary program. These problems are discussed in Section 4.2.6. Problems inherent in the other data collection programs which contribute to the estimation of bycatch, that is the fishery independent survey data and shrimp commercial catch and effort data, are also discussed in previous sections (see Sections 4.2.4 and 4.2.5).

The panel members' reports highlight a number of problems with the estimation procedures presented at the meeting. For example, Kaiser notes that none of the models proposed offer a means of producing variance estimates of bycatch. He further notes that neither NMFS nor LGL were able to provide, at the New Orleans meeting, error estimates for BPUE produced from their models, let alone for bycatch estimates produced by multiplying BPUE by estimated shrimp effort.

Another primary concern, expressed by Fanning, is that the present models used in the estimation procedure do not adequately account for the severe constraints imposed by the data. Christman lists the standard assumptions about the data made by the model: observations are independent, constant variance, functional relationship between dependent and independent variables is correct, and the independent variables provide the relevant information to explain the dependent variable. These assumptions do appear to be reasonable for the fishery independent data since those data were collected according to a standard sampling strategy. However, she considers that the observer data observations are unlikely to be independent because, at a minimum, they are clustered in time, space, boat, observer, and gear. Also the voluntary nature of the observer programs violates the assumption that the observations are randomly selected. Christman believes the assumption of constant variance is very unlikely to be met for several reasons: 1) differences in natural abundance levels by region and the way in which data are collected imply that the mean and variance are proportional; 2) the distinct differences between sampling designs (observer vs. SEAMAP) lead to different variance levels; and 3) since data are often pooled over varying numbers of observations the variances associated with each are also different. There is some variation in the level of importance attached to these various violations of assumptions in the panel members' reports. However in various ways they all independently express concern about the lack of adequate diagnostics in the presentations to assess their significance.

Several of the reports focus on the problems caused by the large numbers of zero valued data cells, which arise due to either no fishing (structural) or, more often, no data from the fishery (observational). Fanning notes that there is no distinction made in the analysis between these two reasons for having zero valued data cells. Kaiser notes that both the linear model used by NMFS and the similar model proposed by LGL at the New Orleans meeting make use of a design matrix (i.e., the matrix of covariate values, X) of less than full rank. This means that a generalized inverse of the $X'X$ matrix is used in solving the normal equations and, hence, that estimates of linear coefficients are not unique. For the prediction of values that do not correspond to columns of the design matrix X this can be serious problem, unless those values all correspond to estimable functions of the fitted model. There was no indication at the New Orleans meeting by either NMFS or LGL that the capability to estimate values for missing cells in BPUE models had been considered by any of these parties. Kaiser believes that this criticism alone is sufficient to render all of the various linear models presented to the panel potentially inappropriate for prediction of BPUE in the overall procedure for estimating bycatch.

All the reports consider the various efforts at reworking the estimation of shrimp effort, which have relied mainly on the GLM model and the same data, with various forms of pooling, which gave essentially similar results. Effectively summarizing the comments of several panel members, Fanning notes that both the current procedures and the recommended alternatives proposed during the meeting rely on indirect means of estimating bycatch and the existence of a relationship between the red snapper catches in research vessel surveys and in the commercial shrimp fishery. All the panel members individually conclude that one of the main problems with any of the potential estimation procedures is the poor quality of the dataset. Consequently, each member expresses the belief that it is unlikely that a reasonable statistical solution can be found for estimation of bycatch using present methodologies and the historic data. Having said that, Kaiser stresses that there are statistical considerations that should and can be addressed to improve the treatment of bycatch issues in the future.

Table 4.1 Commercial Red Snapper Fisheries Data Collection Programs

	NMFS Landings census (including LA and TX State supervised programs)	Mandatory Logbook Program for catch and effort data	Trip Interview Program (TIP) for size frequency data
1. Appropriate design?	• Port agents collect landings data from seafood dealers; • Incentive to under report; • No discard information; • Misses catch sold to any non-dealer (e.g., restaurants, consumers); • Some inconsistencies between national and state schemes should be rectified; • Gear used and area fished provided by port agents based on their knowledge of the fishery, no information on these items from reports provided directly by dealers.	• 100% coverage of vessels with a federal vessel permit since 1992, but does not cover all the commercial red snapper harvest; • Opportunity for comparisons with landings census data - shows good agreement to within 6%; • Discard field dropped in 1996 due to lack of use; Provides information not available from other programs.	• Since 1992 focused on size frequency data only; • Opportunistic or convenience sampling is non-random and may introduce bias; • Some groups of fishers may be systematically missed due to working hours and landing practices; • Provides no information on discards; • At least 50% of the data are aggregated landings collected from the dealer rather than from individual vessels; • Provides data on the size distribution of the landings rather than the catch.
2. Estimation protocol appropriate?	• Complete census results; • Data are apparently used correctly .	• Tabulation of census results, but does not cover non-permit holders, hence it is not clear whether it is a census or sampling methodology; • Logbook presents an opportunity for a formal stratified sampling program targeted at the commercial fishery .	• Data used to characterize (i) the size distribution of commercial red snapper and (ii) the spatial distribution of red snapper by size; • Conversion of lengths to age (Goodyear 1995) appears to be appropriate; • Estimation procedures assume samples are randomly selected; they are not and the resulting length distributions are therefore likely to be non-representative; • Spatial distribution of samples is very uneven; • Location of catch probably poorly defined in aggregate samples; • Uneven probability aspect of sampling difficult to quantify. • Appropriate blocking factors used
3. Sampling level and coverage adequate?	• Sampling adequate for main dealers; • Should determine the portion of landings missed through direct sale to restaurants and consumers.	• Good coverage, but does not cover non-permit holders; • Permits denied if vessels fail to report	• No, it is not adequate - there is little opportunity to take random samples ; • Provides samples of fish brought ashore, not of the actual catch ; • Sampling coverage is adequate .
4. Identifiable biases?	• Potential for census undercount and incentive for under-reporting; • Biases not controllable and not quantifiable ; • relies on port agent experience for information on gear and area fished.	• Incentive for under-reporting by fishers, but reasonable agreement with landings census.	• Non-random 'opportunistic' sampling may introduce bias, but it is not quantifiable; • Uneven spatial coverage of samples, possibly leading to exclusion of large subsets of the population; • Haphazard selection of fish by port agents for length measurement may introduce bias.
5. Precision properly expressed?	• Census with no error assumed, uncertainty not relevant.	• Census with no error assumed, but uncertainty may be an issue since not all effort is recorded.	• No; • Variability results from the sampling design and also measurement error.; • Precision should not be estimated due to non-random sample selection ; • but a measure of uncertainty would be relevant .

Table 4.2 Recreational Red Snapper Fisheries Data Collection Programs

	MRFSS private/rental, charter/head boat and shore	Texas Marine Sport Harvest Program	NMFS charter boat program	NMFS Southeast region headboat survey (Beaufort Lab)
1. Appropriate design?	• Telephone survey for effort data and trip intercept interviews for discards and cpue; • Well designed survey for national coverage (excluding Texas) and estimation of effort by individual anglers; • Random dialing strategy not well suited to local area estimation of variable fisheries, such as red snapper, due to small local sample size; • Particularly poorly suited to collecting information on more rare modes of fishing such as charter boat and headboat effort; • On-going studies to improve the sampling frame for party and charter modes;	• Analogous to the MRFSS; • Well designed and well implemented; • On site rather than telephone interviews; • Shore based fishing not sampled; • Charter boat component also poorly estimated	• Mandatory logbook program effectively refused by charter boat operators; • Voluntary program operated from Panama City Lab	• Mandatory logbook program; • Structured as a census but coverage is variable between years. Presently about 80 to 90% of fishing effort is directly reported.
2. Estimation protocol appropriate?	• Estimators are constructed correctly; • Concern with deletion of large values for number of charter trips in telephone survey; • Concern with use of 5 year running mean for charter boat data may introduce bias; • Insufficient attention given to the comparison of estimates made across programs.	• Estimators appear to be constructed correctly; • Estimation of effort done differently to MRFSS, which may change the variance.		• Sampling bias due to incomplete census and possible non-random sampling not accounted for; • Attempts made to fill in data for missing trip reports, due to poor spatial and temporal coverage.
3. Sampling level and coverage adequate?	• Not best suited to local single species studies; • Sample size and coverage insufficient to characterize the recreational fishing pressure to the desired level of precision; • Private access fishing and night fishing not sampled by the intercept survey; • missing observations are imputed - needs to be considered when calculating precision, otherwise sample sizes may be inflated; • Sample sizes for private and shore modes .	• Sample size and area covered is reasonable; • Lack of sampling shore based fishing, but red snapper apparently not caught in that mode.	• Geographical scope too small to be useful in the overall Gulf of Mexico	• Needs additional resources to intensify coverage to complete census.
4. Identifiable biases?	• Survey personnel have accounted for all obvious sources of bias and continue to improve their procedures; • Adjustments made to account for unsampled populations or for high variance observations may introduce biases.	• Small potential for introducing bias due to assumptions and adjustment for missing data and post stratification required to construct MRFSS-compatible estimates.	• Use of volunteers in the survey introduces unknown bias. • Not applicable at this time	• Incomplete census introduces unknown bias; • Concern over Imputation of values for vessels for which no data exist, other than they made some trips
5. Precision properly expressed?	• design aspects are incorporated in the variance estimation procedures; • considerable attention paid to the estimation of variance, but no indication of how the information is used; • No consideration of uncertainty in size frequencies from intercept interviews .	• Variance only estimated for total landings; • No estimation of variance of within stratum means.	• Not applicable at this time	• Considered but unresolved; • Claim that precision does not need to be estimated because the ratio of recorded trips to unrecorded trips is high is invalid .

Table 4.4 Commercial Shrimp Fisheries Data Collection Programs

	NMFS Landings census	Trip Interview Program (TIP) for catch and effort	Voluntary at-sea Observer Programs
1. Appropriate design?	• Port agents collect landings data from seafood dealers; • All under NMFS supervision, hence no problems of inconsistency; • Port agents assign grid zones to the reported landings based on their knowledge of the shrimp fishery.	• opportunistic sample interviews to obtain catch and effort data; • Non-random sampling; • Suggest shrimp permits and trip tickets would be a better source of information on shrimp effort ; • Deliberate effort to target larger shrimp vessels (Coast Guard documented); • Data collection program inadequate	• Three volunteer observer programs associated with turtle catch reduction research and SEAMAP data; • Regional bycatch research program - a voluntary observer program started in 1992; • Voluntary program insufficient to obtain representative samples.
2. Estimation protocol appropriate?	• complete census of landings.	• Effort data available for a much smaller fraction of the total shrimp trips than are the catch data; • Data used to estimate CPUE of the shrimping fleet in each of 221 cells each month; • Missing data imputed using GLM model; • Used to estimate total shrimping effort; • Excessive number of strata ; • Available data are inadequate for estimating the CPUE for the entire industry, as assumed in the GLM .	• Many tows show zero catch of red snapper, but it is unclear if this indicates that red snapper are not being caught (exclusion from the nets) or there are no red snapper to be caught in the area (low or no abundance); • Areas where no red snapper can reasonable expect to be found should be excluded from the estimation procedure; • See text for discussion of bycatch estimation procedures.
3. Sampling level and coverage adequate?	• data collected as fully as possible.	• Missing vessels which fish very close to the shoreline; • Fewer and fewer captains willing to be interviewed; • Approximately 15% of all offshore trips sampled; • Sample size adequate • Data too sparse for the structure the analysts wish to impose on the estimation effort .	• Observer coverage between 1992 and 1996 insufficient; • 30% of strata used in estimation had no data; • Data clustered spatially in terms of gear, boats and observers .
4. Identifiable biases?	• Small potential for census undercount.	• 1994 review identified several potential sources of bias which are still relevant; • Random sampling of vessels not possible in this fishery; • Deliberate targeting of larger and Coast Guard documented vessels should cease.	• several potential sources of bias, including clustering of sampling and volunteer status.
5. Precision properly expressed?	• Complete census, assumed no variance.	• Estimation of variance not possible without making strong assumptions about the unsampled subsets of the population.	• No precision expressed.

Table 4.3 Fishery Independent Data Collection Programs

	SEAMAP	NMFS Fall groundfish survey
1. Appropriate design?	• Stratified survey design to provide fishery independent information on, distribution, abundance and stock structure for red snapper and other groundfish resources in the survey area; • Over-stratified.	• Stratified survey design to provide fishery independent information on, distribution, abundance and stock structure for red snapper and other groundfish resources in the survey area; • Over-stratified.
2. Estimation protocol appropriate?	• Estimation protocol ignores stratification; • estimation procedure for mean catch/tow was a mean of all tows because of problems with strata with missing observations.	• Estimation protocol ignores stratification; • estimation procedure for mean catch/tow was a mean of all tows because of problems with strata with missing observations.
3. Sampling level and coverage adequate?	• Sample allocation of 1 per stratum precludes design based estimates of variance; • Suggestions of possible expansion of juvenile red snapper distribution may require increase in the survey area.	• Sample allocation of 1 per stratum precludes design based estimates of variance • Suggestions of possible expansion of juvenile red snapper distribution may require increase in the survey area.
4. Identifiable biases?	• concern over the effects of combining data from different research vessels.	• concern over the effects of combining data from different research vessels.
5. Precision properly expressed?	• Sample allocation of 1 per stratum precludes design based estimates of variance.	• Sample allocation of 1 per stratum precludes design based estimates of variance

4.3 The Economics Review

4.3.1 Outline

As with the Statistics Review Panel, the Economics Review Panel was presented with a detailed package of information, in the form of written reports and verbal presentations, on which to base their appraisal of the data and analyses which contribute to the economic ramifications of alternate management strategies for red snapper. In this case there were four specific objectives of the review, to be achieved through the consideration of three specific questions (see section 3.2)

In responding to the task set for them, the four panel members have each produced a separate report presenting their personal professional review of the economic analyses underpinning management of the red snapper fishery and the control of bycatch in the shrimp fishery in the Gulf of Mexico. As with the Statistics review, the four panel members each use a different report structure to present their findings. Whilst each of the reports provide comments on the major economic issues, the depth of coverage of each issue varies between reports, depending on what the individual reviewers have chosen to focus on. In cases where a reviewer has not responded on a particular point or question, this should not be construed as tacit agreement or disagreement with the findings of the other panel members, rather it is simply that on these particular issues, the panelist made no comment.

In order to produce a consolidated report, the details of the reviews are presented in three main sections; the commercial red snapper fishery, the recreational red snapper fishery and an economic analysis of the reduction of bycatch in the commercial shrimp fishery. The first of these is subdivided into subsections focusing on the various alternative management strategies which have been under consideration for the commercial sector at one stage or another, and are discussed in the panel members' reports. These are open access with and overall quota, limited entry, season closures, effort control, 2-tier license, trip limits, split season, first 15 days each month and, Individual Transferable Quotas (ITQs).

Frederick Bell (Bell) considers that an understanding of proposed management regimes must consider the three components (commercial and recreational fisheries targeting red snapper, and bycatch in the shrimp fishery) in a simultaneous model showing how efficient economic outcomes can accrue when they are properly integrated. Thus, he suggests, proposed management measures such as ITQs or a fixed number of licenses, for example, must be imposed on all three economic sectors to evaluate the economic outcome. He believes that a piece meal approach can be useful, but only by integrating the three sectors in terms of economic behavior can an acceptable economic analysis be accomplished.

Ralph Townsend (Townsend) provides readers of his report with a brief explanation of his view of the role of economic analysis in fisheries management, and specifically regulation. He concludes that economic analysis should not be tightly constrained by the immediate or short-run political and legal context. In evaluating the economic analysis conducted on the management of the red snapper fishery, the standard he applies is whether the analysis is both relevant to the immediate regulatory context and still sufficiently independent and broad to educate participants in the regulatory process about fundamental economic forces.

In opening his report, Gardner Brown (Brown) outlines some of the problems associated with economic analysis of fisheries. In particular he believes that harvest cost *functions* for fisheries don't exist, or are so primitive that it is not possible to know with credible reliability how costs would vary with one or more policy changes. He notes that the red snapper fishery is no exception and considers that the problem is further exacerbated by a sport fishery for which *no economic* values are available. In general he considers that the management body considered a reasonable set of alternative policies and made a very good appraisal in light of the data limitations and budget constraint.

The report prepared by James Wilson (Wilson) was considerably longer than those of the other three panel members. In it, he provides detailed comments on the economic analyses undertaken, and on the specific texts of Amendments 8, 9 and 15 to the Reef Fishery Management Plan. This consolidated report aims to summarize these comments and extract the most important recommendations. However, in the interests of producing a balanced consolidated report, some of the more detailed comments on the text of the Amendments are not reproduced here. The reader is therefore directed to Wilson's original report, included in Annex 1, for additional detail.

4.3.2 Background to the economic analysis

This section reflects the information in several reports providing a brief review of the recent history of management of red snapper in the Gulf.

According to Bell, it is recognized that the fundamental problem in the red snapper fishery is overcapitalization(i.e., too many vessels) and that this problem has led to a depletion of the stock and a fleet operating in an economically inefficient manner. Overall quotas were implemented in the fishery in 1991 by the Gulf of Mexico Fishery Management Council (the Council). In the following year a derby fishery started and got progressively worse in succeeding years. Ancillary restrictions on commercial fishing began with a requirement for 50% income from fishing and later included "endorsements" for trips limits of either 2000 pounds or 200 pounds. Minimum fish sizes were introduced and gradually increased from 14" to 16".

According to Townsend, the Council recognized the potential problems of quota management relatively early and analysis of limited entry options began in 1992. Over the period 1992-1995, the Council took a variety of actions that increasingly focused upon ITQs as the most desirable management option. In 1994, the Council approved Amendment 9, which collected the data necessary for making allocations under an ITQ program. Amendment 8 considered three alternative management regimes; open access with an overall quota, a license limitation scheme and ITQs. These management systems had the objective of rebuilding the red snapper stock to the management target of 20%SPR by the year 2019, but their economic efficiency was also considered by the Council. It arrived at the conclusion that an ITQ system is projected to be economically more efficient and is thus "preferable alternative".

The Council approved ITQs in May 1995 and NMFS approval was secured in November 1995. In a budget resolution in 1996 (HR 3019), Congress set a retroactive moratorium on implementation of new ITQ programs. In Townsend's opinion, the legislative history indicates that this action was motivated specifically by interest in the red snapper fishery. In the Magnuson-Stevens bill, Congress extended that moratorium until October 1, 2000. He further explains that because the existing license moratorium and endorsements expire December 31, 1997, the Council must either enact a replacement for Amendment 8 by the end of 1997 or let the existing limitations expire.

Through Amendment 15, the Council moved to adopt the second-best alternative identified in Amendment 8, which was license limitation. Townsend notes that given the time constraints for preparation and implementation of Amendment 15, the Council did not carefully consider options beyond those in Amendment 8 nor did staff prepare additional analysis. Wilson describes Amendment 15 as essentially Amendment 8 without the ITQ option. He suggests that it could be revised with a view to describing how limited licensing could be melded with a future ITQ program, which includes not only red snapper, but other important reef fishes exploited by commercial and recreational fishermen. Also, given that limited licensing appears to be the only politically feasible option to date, he suggests that it may be worthwhile to study the performance of license limitation policies elsewhere. He explains that whilst limited entry in certain regions of the world has failed to

produce the desired effects, it is important to consider this option seriously, and to make suggestions on its application that could pave the way for a more rational introduction of ITQs in the future.

4.3.3 Summary of findings and recommendations of the panel members

The four reports from the members of the Economics Panel present a considerable amount of detail on the economics of management of the red snapper fishery. For ease of reference, this section of the consolidated report aims to provide a brief, at-a-glance summary of the main findings of the panel with respect to the principal issues discussed in the individual reports. Additional detail is provided in the following three sections, focusing respectively on the commercial fishery (4.3.4), the recreational fishery (4.3.5) and the bycatch of young fish in the shrimp fishery (4.3.6).

At the outset, Wilson emphasizes that what is being confronted is essentially an integrated management problem, having at least three well-identified groups who are major stakeholders: the commercial red snapper fishermen, the recreational sector (headboats/charter boats and private fishermen), and the commercial shrimp fishery. He notes that the peer review is ostensibly for the commercial snapper fishery management actions, but suggests that more important issues, having arguably more important economic impacts, involve the other two sectors.

The reports of the members of the Economics Panel are generally complimentary of the attempts made by NMFS to resolve these complex issues. According to Wilson, while there are points of disagreement on detail, analytical vision and possible management options, the basic themes and arguments in support of the analyses are convincing. He considers there is a high level of sophistication and diverse information derived from the economic analyses in Amendments 8, 9 and 15. He specifically elaborates that analyses in support of Amendment 8 are largely anecdotal, but with a number of direct references to notions in welfare economics, while the analyses in support of Amendment 9 are highly organized, largely empirical, though well-grounded in economic theory, and yield some unexpected results which could not have been divined, *a priori*, by intuition. Bell concludes that The Gulf of Mexico Fishery Management Council and National Marine Fisheries Service did an overall excellent job in describing the economic effects of an ITQ system for the Gulf of Mexico Red Snapper and Brown believes the management body considered a reasonable set of alternative policies for the commercial fishery. As with the other panel members, he considers the principal limitation to the analyses was the incomplete integration of the three sectors: (I) commercial; (2) recreational and (3) the bycatch of red snapper by the shrimp fleet.

- The commercial fishery

Several different potential management regimes have been considered in the context of the commercial fishery for red snapper, including ITQs and license limitation. With respect to ITQs, Townsend concludes that the economic analyses in Amendment 8 were sufficient to support the conclusion that ITQs would be the best way to end the derby fishery and, hence, to support the conclusion that ITQs are the preferred management alternative. He further notes that had the data been available to estimate the cost savings under ITQs, the conclusion that ITQs are preferred would have been strengthened. Bell also considers that the economic analysis of ITQ options in Amendment 8 was adequate, although somewhat limited. He cites three fundamental economic benefits of the ITQ system over the *status quo* (i.e., open access and overall quotas) and license limitation systems:

- reduction in fishing effort;
- reduction in fishing cost; and
- improved quality of the catch.

He concludes that despite concerns about the interaction of the recreational fishery with the commercial fishers (see section 4.3.4), it is highly recommended that the proposed ITQ system be implemented as soon as possible. The reason he gives is that it has proved effective almost everywhere in the world in terms of stock rebuilding; reduction in overcapitalization and making the fishery economically more efficient.

Brown also believes that policies other than ITQs are second-best and cause losses in economic benefits for the nation. However, he goes on to summarize a concern, expressed independently by other panel members, that an important qualification to the support of ITQs, on the grounds of economics, is that if the costs of monitoring and enforcement for ITQs exceeds those of monitoring and enforcement for an alternative management policy, they must not exceed the otherwise economic superiority of ITQs. A further concern, mentioned by Brown, is the need to avoid concentration of ownership, through limitation of the number of rights any single entity can own.

According to both Bell and Townsend, the economic analysis of license limitation in Amendment 15 was appropriate, given the regulatory context and time constraints created by the suspension of Amendment 8. However, a common opinion expressed independently by several panel members is that if license limitation is to become the core of red snapper management, then additional economic analysis of limited entry and effort controls is necessary. Townsend also suggest that the relationship between costs of fishing in the commercial red snapper fleet and alternative regulatory approaches (including both ITQs and effort controls) needs to be investigated using the recently completed cost survey (Waters 1996). Notwithstanding these additional analyses, Bell concurred with the findings of the Council that license limitation is wanting in its effectiveness in both rebuilding of the stock and promoting the economic efficiency in the red snapper commercial fishery.

In terms of other management options, Townsend believes the data are clearly adequate to document the negative consequences of reinstating open access or maintaining the *status quo* of license limitation at a level of excess effort. He notes that effort restrictions other than simple license limitation were not considered in Amendments 8 and 15. This is understandable, given that Council had good reason to believe that effort restrictions would be less satisfactory than ITQs. However, he points out that if ITQs are no longer a management option, the Council needs to explore further the alternative approaches to effort control. He suggests that these would include fractional licenses and individual transferable input systems (see section 4.3.4 for details), although implementation of such effort controls needs a clear understanding of the relationship between inputs and outputs and how harvesters will respond to restrictions. In his opinion this evidence is not presently available. The recently completed NMFS economic survey (Waters 1996) should provide some of the necessary data, but an understanding of how industry will respond to these controls will require extensive industry input.

- The recreational fishery

Several panel members express concern about the poor data and lack of economic analysis of the recreational sector. According to Bell, the recreational fishery data are of questionable validity and Townsend believes that the economic analysis of the commercial/recreational allocation and of the regulation of the recreational fleet is not sufficient to adequately inform regulatory decisions. The efforts made by NMFS to correct some significant data deficiencies are noted, and Bell specifically recommends that more research should be undertaken in this area, but he believes that substantial problems are likely to persist. As part of this process, Townsend suggests that the economic value of the recreational fishery needs to be assessed to determine the appropriate allocation between

recreational and commercial fisheries. The planned supplemental survey for the MRFSS should provide data to better address this task. He also proposes that the differences between the headboat/charter boat and the private/rental recreational sectors need to be explored, to investigate whether uniform treatment of these sectors is appropriate.

All the panel members express concern in various ways at the quota overages by the recreational sector. Townsend points out that under the Magnuson-Stevens Act, the Council will be forced to take action to deal with quota overages. Several suggestions are made in the reports regarding the approach to regulation of the recreational fishery and these are described in section 4.3.5.

- Bycatch reduction

Bell considers that the approach to the economic analysis of bycatch reduction requirements under the Shrimp Fishery Management Plan is generally appropriate. However, as do other panel members, he notes that analysis of impacts on the shrimp fishery is more thoroughly developed than the effects on the red snapper fishery and this deficiency should be corrected. Townsend suggests that a comprehensive model of shrimp, commercial and recreational red snapper fisheries, and other impacted fisheries needs to be completed to assess the appropriate bycatch strategy in the shrimp fishery.

The main criticism leveled by several of the panel members is that alternatives to the use of bycatch reduction devices (BRDs) were not fully explored (e.g., Wilson and Townsend). Additional detail on this issue and suggestions for alternative approaches are provided in section 4.3.6.

- Conclusions

Brown concludes his report by speculating that if it were possible to:

- estimate the sport and commercial net economic value of harvest (as a function of harvest level) for each year for many years;
- estimate the population dynamics of the red snapper; and
- estimate the opportunity cost of reducing bycatch to the shrimp fishery,

then the economically optimal recovery rate of the red snapper population could be estimated. He believes, however, that this scale of optimization cannot be undertaken until at least further research is directed at the recreational fishery since there are currently no useful recreational values. He suggests the goal of the optimization exercise would be to equalize the marginal value of the fish across the three sectors (commercial, private/rental and headboat/charter boat) and allocate a fraction of the harvest each year to each. He explains how various uncertainties and practical realities (e.g., the short term prohibition on ITQs in the Magnuson-Stevens Act) could be incorporated in the analysis, but acknowledges that political feasibility is not included. Townsend also believes that the economic value of the recreational fishery needs to be assessed to determine the appropriate allocation between recreational and commercial fisheries. He considers that the planned supplemental survey for the MRFSS should provide data to better address this task. Echoing Brown's division of the red snapper fishery into three sectors, he also believes that the differences between the head boat/charter boat and the private/rental recreational sectors need to be investigated to determine if uniform treatment of these sectors is appropriate. Following on from this, Townsend suggests that the relative impact of minimum sizes, bag limits, and other types of recreational restrictions (such as minimum hook sizes) should be evaluated, with the goal of devising regulations that maximize the value of the fishery to participants.

4.3.4 Economic analysis of alternative management regimes for the commercial fishery

This section consolidates the parts of the panel members' reports which provide specific responses to the question which they were posed:

> *When the Gulf of Mexico Fishery Management Council was considering implementing effort controls for the red snapper commercial fishery, were all reasonable effort management alternatives considered? In addition to ITQ management for red snapper, to what degree did the Council consider license limitation, multi-species effort management, management involving specific geographical areas or other relevant alternatives designed to limit overall commercial effort?*

According to Brown, the most relevant management regimes were considered and the quantitative analysis was suitable, assuming that only existing data were used. Wilson, questions whether "all feasible management regimes and approaches" are being considered in the management process and takes this to mean those options currently discussed in the management literature, which should be readily accessible to the Council and NMFS staff. He notes several factors which may have limited the analytical and management options open to the Council and NMFS, including their selective investment in certain types of information, and the public management structure, legal framework and the economics of the industry. He further suggests that the authors and interpreters of the Magnuson Act have historically been wary of limited entry and ITQs, even though these management approaches organize the industry in ways which are closer to the spirit of free enterprise and individual initiative than management by regulation or community-based commons management. What remains is open access management of effort by regulation and global quota restrictions.

Townsend notes that aggregated species quotas and geographical fishing areas were not seriously considered in the management process, but since these types of management are not common, and review panel was not presented with any evidence that specific proposals were presented in the regulatory process, there is no reason to expect such proposals to have been analyzed.

- Open access with an overall quota

Brown notes that a quota is merely a change from open access to a population, to open access to the quota based fraction of the population. All the economic disadvantages of open access remain. Bell reports his agreement with the findings of Raulerson (1997) that the derby fishery under the overall quota has led to:

- excess capacity;
- safety problems;
- lower ex vessel prices; and
- a dissipation of rents from the red snapper fishery resource.

In addition to these, Brown lists the following more specific effects:

- increase in the unit cost of harvesting and consequent decrease in profit;
- changes in the pattern of landings;
- changes in regulatory policy causing increased uncertainty in the planning horizon;
- increased imports.

Summarizing, Brown quotes the following information provided during the panel meeting:

- fleet size doubled from 1975-1985;
- fleet size tripled from 1975 -1990;
- an annual quota established;
- the length of the season dropped from 235 days to 51 days;
- dramatic price decrease induced by the pulse fishing activity (when industry quota is a constraint, the quota causes a loss of real ex-vessel price of $0.85 per pound).

Bell considers that the overall quota system has sent a false economic signal to the fishermen, embodied in the rising catch or TAC, which has induced optimism, yet the industry is characterized by gross inefficiency. In Bell's opinion, the overall quota system has been demonstrated to be grossly inefficient from the yellowfin tuna fishery on the West Coast to the yellowtail flounder fishery on the East Coast of the U.S. Elaborating on the safety problems caused by the derby fishery, in which harvesters are more likely to venture out in bad weather, Brown notes that the owners of small vessels are actually discriminated against, because small vessels are more vulnerable to bad weather than are large vessels.

Referring to depreciation in value resulting from market glut, Bell notes that derby fishing within the context of an overall quota actually decreases industry revenue during the short quota periods. He concludes that the nature of red snapper demand is critical in evaluating the economic impact on the fleet. The price may also be affected by increasing imports (from about 0.5 million pounds in 1990 to 2 million pounds in 1996).

- Limited entry

In Brown's opinion, limited entry merely concentrates what he refers to as the rushing (i.e., derby fishing), the capital stuffing, the increased danger, the decreased price and the increased harvest cost to those fortunate enough to own the privilege of remaining in the fishery. Each of the insiders has an incentive to capture as much of the quota as he/she can. The owner of an entry right buys as much of every possible element in the vector of fishing power as long as he/she thinks its cost will be covered by expected additional harvest revenues. Bell also notes that license limitation almost universally results in gradual increase in fishing effort as technology improves and fishermen find new ways to outwit the regulatory authority.

Wilson cites examples of both success and failure of limited licensing management strategies. He explains that limited licensing is relatively successful in Alaska is because:

- Gear types are defined;
- Species (salmon and herring) are defined;
- Areas are defined, and;
- Fishermen had to be involved, through contributions to hatchery investments and other activities, in the enhancement and development of salmon stocks in their regions.

He considers that failures in limited licensing have more to do with problems in the application of the tool rather than the tool itself. For example, the British Columbia salmon program had a government-administered buy back program to reduce effort, but since it was not self-funded, it ran out of money early in its existence.

- Season closures

Brown explains that season closures, combined with limited entry, partition in time the open access phenomenon and its consequences. Prices, therefore, continue to fall each time the fishery is opened. He poses the question that if splitting the season is good, why not divide the season up into many intervals? Although he acknowledges that this would imply that a federal agency knows best when to allow and when to prohibit harvesting, and that there is some evidence to support a policy which dictates when all harvesters should concentrate their harvesting activity. Brown has not seen evidence to show that efficiency or equity is enhanced by such a uniform policy. He suggests it would have to be based on some form of asymmetric information which one or more government agencies have, and is too costly to distribute to the harvesters. Without such evidence, he considers there is no reason not to design a policy which gives harvesters the choice of when to fish, as long as the biological goals are met, and that it would be difficult to allow this freedom except under an ITQ system.

- Effort controls

Townsend attributes the successful reduction of effort and fishing costs in some fisheries to the application of effort limitations, such as limits on the number of traps, or allocations of fishing days. He notes, however, that there are disadvantages in that harvesters have incentives to undermine the restrictions by increasing the use of unregulated inputs (such as crew size or gear design). He believes that the success of effort control strategies depends upon the specific characteristics of the fishery. For example, he suggests that the multispecies nature of the Gulf of Mexico reef fishery might raise particular problems. He suggests that an examination of the feasibility of effort limitations will require not only greater economic analysis but also extended discussions with the industry. The disadvantages of effort limitations must then be weighed against the clear costs of a derby fishery. In any event, he notes that the options of the Council for effort control are restricted by Section 407 (b) of the Magnuson-Stevens Act. That section has a moratorium on red snapper plans that authorize "the consolidation of licenses, permits or endorsements that result in different trip limits for vessels in the same class". When the moratorium expires, a referendum of the industry is required to implement such regulations.

Townsend is concerned by the scope of the cursory economic analysis in Amendment 8 of how license limitation might work in the red snapper fishery. He cites the core economic problems of license limitation identified on pages 13-14 of the final Amendment: For license limitation to end the derby, either:

(a) the number of licenses would have to reduced by as much as 75%, which would face immense political opposition, or

(b) effort would have to restricted by increasingly cumbersome and onerous restrictions on trip limits and fishing time.

But, he points out that the discussion did not examine options such as transferable fishing-days or other forms of individual transferable inputs ("ITIs") and explains that in some fisheries, ITIs (such as trap limits in lobster fisheries) have been effective. The New England Fishery Management Council has adopted non-transferable days-at-sea programs in both its scallop and groundfish industries. He suggests that greater depth in the analysis of license limitation and effort control was warranted.

According to Brown, with rare exceptions, effort control is inferior to an ITQ type policy. He believes that effort control cannot be supported analytically except under exceptionally restrictive assumptions and it has been rarely tolerably economically efficient. His argument is that, in comparison to ITQs, effort controls are an indirect approach to defining the property right (the right to harvest fish). ITQs fix the harvests taken by all the agents in the fishery, and the target harvest is automatically achieved, *assuming no cheating*. By contrast, in order for the target harvest to be achieved under effort control, the regulators have to fix *every* element of the operation (the 'production function') which are necessary for the harvest taken by each agent. The more uniform the production function across harvesters, the easier the task of effort control becomes. However, the harvesters are not uniform in gear skill or days fished in the red snapper fishery. Similarly, the smaller the number of element of the operation which are necessary for the harvest the easier it is to establish effort control. But there is not excellent information about this. Brown also point out that each time technology or the price of any input changes, if the regulators don't respond appropriately, fishermen will lose money using the old technology and will have an incentive to circumvent the rules legally and illegally.

Brown concludes that to establish sound effort controls, it would be necessary to obtain time series data on the inputs that determine fishing power and prices for these inputs. Since none of those data exist at present, the time series would have to be long enough to provide the desired statistical accuracy, which he suggests is more than a decade. Such data are not necessary to implement ITQs.

Amendment 15

Several panel members make specific comments about the effort and other controls in Amendment 15. Amendment 15 proposes a two tier license system (one type for "full time" fishermen and another for part time fishermen based on the catch over the period 1990-1992), to limit catch per trip, to split the season into spring and fall, and to limit harvest to the first 15 days in each month. Brown believes these policies can reduce, but not eliminate, the rushing associated with the derby fishery, and therefore cannot eliminate the attendant costs of rushing which this policy regime causes.

Echoing the concerns of other panel members, Townsend warns that the cursory economic analysis of license limitation in Amendment 8 becomes a more serious liability in Amendment 15. He believes that the proposed controls on fishing effort will create annoying problems for all concerned: the harvesters, the buyers, and enforcement. With respect to the potential for reducing effort, he notes that under Amendment 15 the Council does not have the option of using attrition as a license reduction strategy because the licenses are transferable. License buy-backs, he thinks, are an attractive option, but as noted in Amendment 8 they are unavailable under the Magnuson Act. He suggests two scenarios which might be ways around this: firstly an independent association of harvesters that finances the purchase and voluntary surrender of licenses, and secondly, a state program using license fees to finance the purchase of excess licenses.

In mitigation of the effort reduction problem, Townsend suggests that once Amendment 15 is in place, a careful examination of either (a) license reduction or (b) effort-per-license reduction (with or without transferability) is required. As an example, he proposes that license reduction could be accomplished by fractional licenses (Townsend 1992; Townsend and Pooley 1995).

In summary, Brown makes the following specific comments about the controls proposed in Amendment 15:

- The policy regime increases uncertainty, but there are no data on the specific effects on efficiency, equity and safety. NMFS or the Council should undertake some indicative planning using historical landings data with reasonable assumptions.

- The extent to which limiting the harvest to the first 15 days of each month limits price fluctuations will depend on the responsiveness of harvesters to 'beat the clock'.

- Safety may be reduced for the following reasons:

  - Trip limits redistribute catch from larger, relatively high volume to smaller, relatively low volume boats, the latter being relatively less safe.
  - Trip limits increase the days fished and because the boats in each tier must compete against the others in a derby each month, the increased total volume of days increases the danger in the fishery.
  - There is no evidence that the first part of the month is safer than the last part.
  - If the more productive skippers take better care of their boats, and therefore they are marginally safer, then the trip limits are a further source of enhanced danger

- Trip limits and time closures increase uncertainty because the skippers have to plan their harvesting strategy each month not knowing when the closure will occur. They further don't know when the trip limit will occur.

- The uniform policy for each tier discriminates against some gear types because they are not all equally suited to the constraints. For example, historically, bottom longline gears are disproportionately preferred in March, April and May so those harvesters are discriminated against by a fall season

Bell questions whether the transferability of licenses should be limited to the commercial fishery. This conflicts with a basic economic principal and that is that the market should determine who holds property or quasi-property rights to a resource. He explains that the limitation would preclude, for example, a conservation society or an organization of recreational fishermen, who wished to "buy" a right to preserve or use the red snapper resource, out-biding all commercial fishermen at an auction. Thus, Bell believes an economic link between the commercial fishery licenses and their respective value on the real open market is severed. He believes the Council has not dealt with this issue on even a research basis because of its political sensitivity. He concludes that history, empirical research and economic theory must categorically reject the license system as a means to solving the tragedy of the commons and notes that it is to the Council's credit, that they have recognized these profound limitations and have rejected its adoption as a viable alternative.

- ITQs

Summarizing the independently expressed views of other panel members, Townsend states that both economic theory and empirical evidence from a variety of fisheries strongly support the central premise of Amendment 8: that ITQs are generally very superior to license limitation, and that license limitation is almost always very superior to open access (see also Townsend 1990 on limited entry and Grafton 1996 on ITQs). Bell describes as "brilliant" Water's 1997 analysis, which enabled the identification of

the impact of the overall quota system on the demand curve for red snapper. This leads to the estimation of possible rents in the fishery if the overall quota were replaced with an ITQ system. He further considers that an ITQ system comes to grips with the basic problem in the fishery, which is the lack of well defined property rights. Under the system there would be transfer of property rights from the US Government to the fishers. According to Townsend, the Council received very appropriate economic analysis on these points throughout the development process (e.g. Waters 1991), and notes that the Council arranged for meetings with the industry to examine these issues (Orbach 1993). He further notes that by the time Amendment 8 was adopted, there was considerable industry support for ITQs , as well as significant remaining opposition (Thomas *et al.* 1993).

Summary of advantages cited by the panel members

The following economic advantages of an ITQ system over other approaches to managing the red snapper fishery were cited independently by the members of the economics review panel:

- By individualizing the fishery quota it greatly or completely reduces rushing (ends the derby);
- it reduces the cost of fishing per unit effort;
- it increases the landed value due to the end of the derby;
- it increases participants' earnings;
- it may reduce overcapacity and fishing effort significantly, as shown by other fisheries, although no quantitative estimates were made for the red snapper fishery
- By removing competition between skippers on the fishing grounds, safety is increased compared to other quota systems (assuming the overall quota is the same in each case);
- According to a survey, among red snapper harvesters there was a modal preference for an ITQ policy as the harvesters look forward in time;
- Harvest control on each vessel should be more economically efficient than effort control on each vessel, depending on the relative costs of enforcement - see below;
- the more efficient harvesters would pay the less efficient more than they could earn for their rights to fish

Townsend concludes that the analysis of the price effects in Amendment 8 alone was sufficiently compelling to warrant the conclusion that ITQs were the preferred alternative. He believes that a detailed analysis of cost savings, which was not included, would simply have made the case for ITQs stronger.

Bell presents a 'quick and dirty' spreadsheet based re-analysis of the economic benefits derived from the ITQ system, which corrects the economic benefits presented in Amendment 8. The main change is the conversion of the benefit evaluation from 1982-84 dollars to 1996 dollars (to conform to the values used for the evaluation of cost). He acknowledges that the estimates derived are very crude, but notes that they demonstrate that the ITQ system, if not impacted by negative variables (e.g., the recreational fishery), will generate considerable economic rents to those participants that are granted

the initial allocation. He notes that this will take place in the 1997-2019 time period while the stock is being rebuilt. After 2019, rents may increase as the TAC is increased. The implementation cost is estimated at $.428 million and the annual cost of enforcement, etc. is estimated at $0.659. Without discounting, the net economic benefits on an annual basis will be $4.231 million ($4.89 less $0.659 million). Thus the benefit/cost ratio will be about 6 to 7 for this undertaking and ITQs are clearly cost effective.

Concerns expressed by the panel members

Quoting the figure reported by Raulerson (1997), Bell expresses a concern shared independently by several panel members, that the implementation cost of an ITQ system is 20 to 25 percent higher than either the status quo or the license limitation system, and the annual running costs, assuming the high enforcement scenario, may be nearly three times as expensive. He also notes, however, that it is not entirely clear from the analyses just how these figures were derived. Brown considers that if the costs of monitoring and enforcement for ITQs exceed those of monitoring and enforcement for an alternative management policy, they must not exceed the otherwise economic superiority of ITQs. He notes that there are no data on this issue, but he considers that the nature of the red snapper fishery gives no persuasive reasons to believe that monitoring and enforcement costs are disproportionately high for ITQs.

Townsend notes that NMFS has moved appropriately to address the data limitations on costs in the red snapper fishery. They have recently conducted an economic survey of the commercial red snapper fleet (Waters 1996), but this new data set, including both fixed cost data and trip-level data has yet to be applied to econometric analysis of costs in the industry. The data set includes information on trips that target species other than red snapper or reef fish. Townsend believes the fleet coverage is quite good and notes that the data collection protocol made extraordinary efforts to avoid sampling biases. He further notes that while the data have great potential for estimating switching behavior in response to regulation, they cannot be used to construct total annual costs for any vessel that is engaged in more than two different target fisheries. This is because to avoid extremely long interviews, data were collected only for the two most important target fisheries.

Bell endorses the denomination of ITQs in percentages, in recognition of the potential variation in the TAC between years in response to exogenous biological factors, but he expresses concern over the four year duration chosen by the Council, after which the program may be extended. Bell prefers a longer duration for issuing ITQs and believes that the four year caveat is likely to undermine the perceived value of the asset being transferred to the fishery. He sees no basis in reviews of existing ITQ programs for an introductory period. It may cause banking institutions to regard ITQs as risky collateral for loans to fishermen, who may be seeking to upgrade their vessels, a development that would help to improve the efficiency of the fishery. Bell notes that in focus groups 21% favored ITQs , leaving nearly 80% who may be opposed to the new system. He believes the introductory four year period will further undermine a fragile proposal as it now stands. He also notes that because of the little long term control of fishing effort by the recreational sector, the effectiveness of ITQs in the commercial sector may be threatened (see also section 4.3.5). If the rents in this latter sector are reduced, then fishers will have less incentive to stay within their individual quota.

Three issues regarding the allocation and transferability of assets were of concern to Bell. Firstly, regarding the initial allocation, he notes that while the ITQ proposal recognizes the importance of the historical captains of vessels, it fails to consider labor as a participant in the potential transfer of wealth. He questions what economic benefits, if any, will accrue to deckhands as a result of the ITQ system, and stresses the importance of gaining the confidence of all fishermen when introducing it.

Secondly, Bell suggests there are serious problems in the provision for persons eligible to transfer ITQ shares. He believes that the Council's preferable choice of the conditions for transferability may deprive the shareholder of considerable asset value, which would undermine the system. In his opinion, Alternative 5 is most easily justified on economic grounds, allowing persons who are not fishermen to buy up shares. There may be those outside of the commercial sector who would be interested to buy shares, ranging from conservation groups wanting to preserve the red snapper, to recreational fishermen wishing to increase their catches by leaving part of the TAC un-taken. He notes that commercial fishers can only be removed by outside forces if they are willing to sell their share derived from the initial allocation.

The third transfer issue addressed by Bell is concentration of ownership, or the tendency toward monopolization. He notes that elsewhere in the world there has been great concern over this issue, but cites two important conditions which argue against such a result for red snapper in the Gulf of Mexico. First, the demand curve is highly price-elastic. High prices may reduce whatever share of the reef fish market red snapper still retains. Second and more importantly, he believes an attempt to raise prices by market power would induce a flood of imports, thereby defeating such an attempt. He concludes that the best interest of all is served by low ex vessel prices in the red snapper fishery, and agrees with the Council that their should be no limit on the ITQ shares.

Other issues

One final point raised by Bell regarding ITQs is that there is apparently no discussion of the basis for transferring a valuable property right to the commercial fishermen other than to cite the provisions of the Magnuson-Stevens Act. He cites a number of examples from around the world where fees are collected for catch quotas, not as a resource rent, but as a use charge, for example to cover the cost of management and surveillance. He urges the Council to consider the application of a user charge as an issue of current interest and future research and recommends that the Magnuson-Steven Act be amended to include the provision for such a fee. He also suggests that the Council might consider allocating a share to itself, sell it at the appropriate time and manage the red snapper fishery on the proceeds from the invested endowment.

As indicated in section 4.3.1, Wilson provides a number of detailed comments on the text of the Amendments, which will not be repeated here. Many of these relate to the proposed implementation of ITQs and other issues in Amendment 8. They relate *inter alia* to issues such as the minimum quota needed to enter the fishery, and how one can obtain this, the mechanics of reporting of data, and cost estimates for the tracking system.

4.3.5 The recreational fishery for red snapper

As Wilson explains, the main focus of the peer review was on the economic analysis of the commercial fishery for red snapper. He notes, however, that there is obviously substantial interaction between the management of commercial sector and the large recreational component of the red snapper fishery in the Gulf of Mexico. At present, 49% of the overall TAC for red snapper is allocated to the recreational sector (the headboat/charter boat sector and the private recreational sector as a single unit), based on historical participation. However, this quota has been exceeded every year since 1991.

Assessment of recreational fishing demand

In view of the size of the recreational allocation, several panel members express concern about the apparent marginal treatment of the issue of recreational fishing demand. Wilson, for example, thinks this is one of the most disturbing aspects of the management initiatives to date. Townsend notes that a low priority has been placed on developing economic analyses of the recreational sector. He warns, though that changes in recreational demand will eventually render the present allocation inappropriate and urges the undertaking of an economic analysis to evaluate the importance of these changes. The key issue for such an analysis would be the relative value of red snapper as commercial landings versus its value as a recreational target. Townsend considers that economic analysis to date has been severely limited by large gaps in the information, but there are suggestions that the recreational value of reef fish is quite high. This accords with the report of Bell, which notes that the recreational fishery generates immense economic value as measured by user value (i.e., consumer surplus) or economic impact on local communities and states. Brown acknowledges that valuing recreational catch properly is not easy, but he expresses surprise that no attempt has been made, and that no data have ever been made available that informs policymakers about order of magnitude estimates for a substitute recreational fish in the region which might provide some sense for possible values. He questions this situation, particularly given that about one half of the TAC has been allocated to the recreational sector for a number of years. In conclusion, Wilson recommends that the Council and NMFS commit to the development of an integrated policy on recreational fisheries of reef fishes, and red snapper in particular, which will at least make the sector respect the existing apportionment.

Comments on the MRFSS add-on economic survey

Townsend notes that NMFS has initiated action to substantially increase the available economic data to assess recreational demand for red snapper in the form of a supplemental economic survey for the Southeast MRFSS. Wilson suggests ways in which it could be altered to improve the response rate and data quality. He considers that some of these questions are far too complex to respond to over the telephone. He proposes that the quality of responses would be greatly improved if the intercept questionnaire was folded into the main questionnaire, and the contact time was spent getting the respondent interested in actively participating in the study. The main add-on questionnaire could then be physically given to willing participants, and a telephone rendezvous could be set for two weeks later, at which time the information could be recorded. That way, Wilson believes, complex questions requiring mileage calculations, budgets, costs, and multiple trips could be worked out before the interview begins.

Brown also points out some problems with the survey. He suggests that, ideally, the stages of research proceed by:

- developing a theoretically consistent model;
- deriving a set of estimable equations;
- designing a survey [in the present instance] to collect the data called for by the model; and
- specifying the error structure; etc.

But in this instance the procedure has been that a number of researchers were assembled to discuss approaches and to review a survey. He expresses three specific reasons for concern:

- how can we be assured that there is a good match between the data set and the needs and capabilities of the chosen researcher?
- how do we know that the estimable models are state of the art? and most important, in his view,

- how do we know that the data collected are appropriate?

With respect to question 3, Brown notes that any reputable contingent valuation study is preceded by a series of one or more procedures for ground testing the adequacy of the surveys. This was not done. He also considers that the open ended contingent valuation question is wrongly worded. Finally, the order of the valuation questions and their nature suspiciously resembles that of the design for the double bounded dichotomous choice models ["Would you pay X_i?" X_i varies across the sample. Conditional on the response, "would you pay $\{Y_i, Y_j\}$?" (Y_i is a value if the first response is no. Y_j is a value if the first response was yes)]. The published and unpublished results of this question format, that Brown is aware of, are a disaster. Theoretically, the distribution of responses to the first and second questions should be equal, but they are not. Brown reports that it has been hypothesized by some of the leading experts that the design of the questionnaire induces irrationality. He also notes that many of the important advances in contingent valuation analysis are unpublished and recommends that agency economists seek substantial guidance from specialists in the conduct of *applied* recreation valuation analysis.

Wilson also suggests that the add-on survey should be reviewed by researchers interested in these types of issues and field tested at least two times, one with a focus group made up of recreational fishermen, and another with a small group of fishermen which are intercepted and asked for their help in reviewing the instrument by filling it out. It is important for NMFS and their contracted interviewers to realize that they are, in the eyes of at least some recreational fishermen, nuisances. In dealing with nuisance calls, two approaches (which are fatal to a survey) are to tell the interviewer anything if it gets too difficult to answer, or to refuse to answer. User-friendliness, both in human form and in the survey, may help reduce this tendency. In his extensive report, Wilson also makes some additional recommendations about specific questions in the survey, particularly the contingent valuation component, which will not be reproduced here. The reader is referred to his full report in Annex 1 for details. In conclusion, however, he strongly encourages the organizers of this enquiry to rethink their instruments and the survey protocol to make it easier for respondents to give accurate answers. He suggests that NMFS might also think about obtaining support for their survey from sport fishing associations in order to reduce the "nuisance" factor and also to provide some advance publicity for their efforts, as long as it remains an independent survey.

Future management of the recreational sector

Bell considers that if the trend of exceeded quotas continues, it will seriously undermine not only the rebuilding of the stock, but the introduction of the ITQ system for the commercial fishery. He goes further and suggests that the failure of Amendment 8 to address what he believes to be the most obvious expansion in recreational fishing effort in the future is almost grounds for rejecting the ITQ system. He is concerned that so much research has been aimed at controlling fishing effort in the commercial fishery sector, but almost no research has been directed toward controlling recreational effort in a meaningful way. He thinks that overall quotas would be almost impossible to enforce with so many anglers. The bag and size limits used by the Council, he regards as 'temporary Band-Aids'. He notes that if the catch rate elasticity displayed by single day trips for reef fish is the same for red snapper, it is quite likely that a declining catch rate or reduction in bag limit will have a moderating influence on the expansion in fishing effort by red snapper anglers, because for example, as Townsend points out, the reduced bag limit detracts from the fishing experience. However, Bell believes that the inescapable conclusion based on the literature is that angling fishing effort for red snapper will increase greatly over the period in which the stock is projected to recover and the ITQ system for the commercial sector is introduced. Bell concludes that the success of management efforts is severely threatened by this trend. As alternative strategies, he suggests reduced length of fishing season could

have limited success along with some form of stock augmentation via hatchery operations. Townsend points out that the possible changes in fishing effort described above are inconsistent with the assumptions of fixed recreational effort in Holiman (1995).

Bell cites data from the MRFSS, which show a slight downward trend in number of fishing trips over the period 1991 to 1996 and explains that he believes these data are very suspect. With rapid growth in population and affluence in the Gulf States he would expect that the actual trend would be the reverse. Townsend explains that, while there is a national trend toward lower fishing participation generally, there may also be a trend towards increasing fishing activity during away-from-home vacations (as opposed to local trips on weekends, etc.) These forces may be fundamentally different in Florida, which has a very large vacation industry, as compared to the rest of the Gulf.

Townsend notes that the MRFSS data also show that charter boat catches of red snapper increased steadily over the period 1990-96, while private/rental red snapper catches decline significantly in the period 1993-96. This suggests very different responses to stock conditions and regulations by the different recreational sectors. He suggests that economic analysis should be presenting this kind of background information to the regulatory process.

The recommendation made in several reports is that research should be undertaken on ways of controlling fishing effort in recreational fisheries including bag and size limits and other measures such as minimum hook sizes. The relative impact of different approaches should also be evaluated with the goal of devising regulations that maximize the value of the fishery to its participants. Bell suggests that the feasibility of a regulation to make the release of sport fish mandatory should be considered. Townsend recommends that the analysis of minimum size regulations should be approached from a Beverton-Holt framework, in which effort, size-selective regulations, and yield are interdependent. Information on natural mortality and on mortality from release can be built into the model to predict the impact on future catch and size distributions of changes in the minimum size. Townsend points out that Beverton-Holt analyses of other hook fisheries indicate that minimum hook sizes may be able to accomplish very similar (or superior) results as minimum fish sizes. He suggests two possible advantages to such an approach: avoiding the mortality associated with catch-and-release and better acceptance by recreational harvesters. He concludes that while some of the biological data necessary to conduct this analysis may be unavailable, economic analysis should at least identify the potential importance of this line of analysis.

All the panel members express concern in various ways at the quota overages by the recreational sector. Townsend points out that under the Magnuson-Stevens Act, the Council will be forced to take action to deal with quota overages. According to Wilson, the panel was assured during the hearings that the enforcement of the quota would occur during 1997 through quota closure. However, it was never clear exactly how one could determine when the quota was attained. Wilson regarded this as a major weakness of Amendment 8. Townsend suggests that the answers to the problem may differ between the private recreational and the headboat/charter boat sectors, which raises the possibility of separate regulatory structures for these two recreational sectors. In this regard, Wilson suggests that the implementation of a positive in-season management program designed to close the recreational fishery upon quota fulfillment, should be a high priority. One possibility he proposes is to develop, along with the LL or ITQ plan, a "snapper tag" program, similar to the salmon tags used to control catch and possession limits in Quebec.

4.3.6 Economic analysis of the reduction in bycatch by the shrimp fishery

As explained in the Statistics review section, reduction of the bycatch of juvenile red snapper by the Gulf of Mexico shrimp fleet is considered to be an integral part of the rebuilding of the red snapper stock. Bell explains that it has long been recognised that the shrimp fleet discards many different kinds of young fish, which later in life are the target species of other fisheries. Brown notes that bycatch of red snapper by the shrimp fishery is the third major non-natural source of mortality. The current goal is to reduce bycatch of 0-1 red snapper by 50% in 1997, which, according to the NMFS assessment, will achieve the target SPR of 20% by 2019.

Bell considers two main questions with regard to bycatch reduction:

(i) what impact, if any, will a bycatch reduction of 50% have on the shrimp fleet? and
(ii) do we have the technology to achieve this objective?

Responding to the first question, he suggests that the main impacts of adding a technological device to a shrimp vessel are the potential increase in cost and reduction in productivity. This is discussed in more detail below.

In answering the second question, he believes the technology is available, citing the results presented by NOAA (1997), which indicate that the Fisheye bycatch reduction device (BRD) (12 times 5) reduces the bycatch of snapper by a mean value of 51%. Wilson notes assurances from the NMFS Pensacola laboratory staff that the BRDs which are designed to meet this target will be adopted by the shrimp fleet. However, he also notes what he describes as the voluminous, voluble, angry, and, on some points, well reasoned testimony of the industry which points to the contrary.

In commenting on the specific text of Amendment 9, Wilson points out some apparent confusion. In the proposed alternative C.1, it is understood that any adopted BRD has to demonstrate that it reduces the average bycatch **mortality** of snapper by 44% (because there has been a 10% decline in mortality due to exiting firms). On the other hand, the Gulf of Mexico Fishery Management Council's goal is also stated as a **50% bycatch reduction** (as indicated above). Other parts of the text talk about a 44% **bycatch reduction**. He concludes that unless the Council and NMFS are willing, for every single BRD ground proof, to make a comparative determination of the **mortality reduction** implied by reduced bycatch, then they may just want to settle on a **bycatch reduction figure** (44% or 50%), which seems easier to measure. He also suggests that the language of the BRD certification criterion should be changed to say that ground-proofing **will** (not should) report measures of:

- comparative (between gear) fin-fish bycatch by species;
- shrimp loss;
- handling times for each gear and sorting times for their respective catches; and
- special operating tactics necessary to make the technology work.

He goes on to suggest that once it is established that a BRD meets the bycatch requirements, the BRD certification **will** (not should) include language that requires proofing on an actual working vessel under commercial situations, and that the same measurements be taken as well as the estimated costs of use and handling of the gear and the resulting catch. This should include fuel consumption and sorting times. In addition, both performances will be reported for a certified BRD in the *Federal Register*. Wilson explains that the objective of this proposal is to encourage the collection and transmission of as much information as practicable on the likely **costs and benefits** of using a certain BRD technology on an actual fishing firm, and that this information is made public. This way, he believes, all of the debates over the costs of using the equipment will be enriched with real data.

Townsend explains that in principle, the economic objective of bycatch reduction is to maximize the economic return from the resources produced by an ecosystem. This logic leads to the solution that bycatch in the shrimp fishery should be reduced until the marginal cost of bycatch reduction equals the marginal benefit of bycatch reduction. This requires information on the costs and benefits of bycatch reduction. Townsend reports that in general, the information about the costs of bycatch reduction in the shrimp fishery is much better than the information about the benefits of bycatch reduction in red snapper, while other impacted fisheries are largely ignored in analysis to date.

According to Townsend, the absence of integrated analysis seems to reflect:

(i) data limitations in the red snapper fishery;
(ii) the apparent treatment of 50% shrimp bycatch reduction as an exogenously-determined target; and
(iii) an apparent decision not to include economic analysis of impacts on red snapper in Amendment 9 to the Shrimp FMP.

Reviewing the work of Ward (1994), Townsend suggests that, while it is informative, it is not entirely appropriate for the shrimp/red snapper case. He is particularly concerned with the use of the Schaefer production model, which is not age structured and assumes that the pounds not taken as bycatch are caught by the red snapper fleet. Townsend notes that this does not accurately represent the size selectivity of the two fleets. The shrimp fleet take juveniles and the red snapper fleet take recruited adults, so the effects on the biomass are in fact not identical. He also recommends that the analysis should be extended to analyze how ITQs or effort limitation in the shrimp and/or red snapper fisheries might affect economic rents and how alternative regulatory approaches in the recreational red snapper fishery interact with bycatch reduction.

Regarding the quantitative analysis of the impact of various BRDs upon the shrimp industry provided in Amendment 9, he believes the analytical approach is reasonable, but that the presentation does not adequately explain the results. His concerns were somewhat allayed by John Ward's subsequent updating of the estimates in Table R-17 on page 101 of Amendment 9 (also referred to by Wilson), but he maintains that if this model is to be the primary tool for analyzing shrimp regulatory changes, it should receive further review (as does Brown - see below). Townsend also points out that the presentation fails to make clear that the results are entirely driven by changes in infra-marginal rents for producers. The major effect of BRDs for producers is to increase costs. In principle, cost increases can either increase or decrease infra-marginal rents. He is doubtful that the necessary data is available to truly estimate the distribution of cost effects among producers, and has great skepticism about estimates of changes in infra-marginal rents. He concludes that the analysis should indicate the potential limitations in this area.

By apparent contrast, Bell regards the model from which Ward derived his conclusions regarding the impact of requiring the shrimp fleet to use the Fisheye technology as one of the most sophisticated economic models he has encountered in the literature. Given the apparent negligible effect of adopting a BRD (no significant change in the equilibrium fleet size or shrimp catchability, small increase in operating cost offset by the increase in shrimp price) he considers that the burden really falls upon the shrimp industry to demonstrate just why these conclusions are not correct. Bell notes that they sent no representatives to the peer review meeting in New Orleans so the committee could better understand their concerns.

Likewise, Brown finds it a little difficult to understand why the shrimpers should be upset with a bycatch reduction program that causes no change in abundance, increases total producers' surplus by about 300 million dollars over open access (result in Ward's analysis) and causes a mere reduction of

about 9 vessels from more than 2,900 (note, there is a minor inconsistency here with Bell's report, which reports Wards model as predicting a change from an initial equilibrium fleet size of 3,148 vessels to a new equilibrium of 3,149 vessels after the adoption of the BRD). In fact this is sufficiently perplexing for Brown to include the caveat that he reports Ward's results, but he has not vetted them.

Brown frames his review of the economics of bycatch reduction in a different way to Bell. He regards the questions of economic interest as:

(i) rank the least cost alternatives (to the shrimp fishery) for reaching the stated goal of bycatch reduction; and
(ii) what is the economic gain to the red snapper fishery from reducing catch?

In considering (i), he cites the results presented in Table R-17 in Amendment 9 for three different types of BRDs. However, at least in part, the results tabulated in his report (Table 2), appear to be different to those in Bell's report. Bell reports that the Fisheye (12 times 5) reduces bycatch of red snapper by a mean value of 51% (see above), but in Table 2 in Brown' report, the value for the 'Fisheye 30' (reduced abundance ?) is 31 to 34%. This may be because the latter refers to all finfish. Brown concludes that if the shrimp fishery was modeled accurately, the commercial shrimpers should prefer the BRD that creates the most producers' surplus. According to his Table 2, this is option (1) - the extended funnel BRD.

As with Townsend, Brown reports that no estimate has been made of the economic gains to the red snapper sport and commercial fisheries as a result of requiring BRDs in the shrimp fishery. Moreover, he believes that the effect a BRD policy has on the shrimp fishery is really unknown, since Ward's baseline is open access, not some policy which includes restricted access.

In summary, Wilson concludes that the analyses supporting Amendment 9 were well reasoned and complete. He had no difficulties with the main results of the analyses in their revised forms (i.e., as revised by Ward subsequent to the panel meeting). His main criticism, however, is that he believes there are alternatives to the use of BRDs which were not fully explored. Regarding the use of season closures, Townsend, Brown and Wilson all mention the analysis of Hendrickson and Griffin (1993). Townsend and Brown believe this work supports the conclusion that BRDs are economically superior to closed seasons. However, Brown considers their economic models to be inferior to Ward's, and Wilson notes that the analyses were done with large area closures in mind, such as the Cooperative Texas Closure. He further notes that in the written testimony, some shrimp fishermen make reference to the Texas Closure as a desirable thing, deserving to be emulated throughout the Gulf.

Wilson examines the history of how policy making came to revolve around the technological fix of BRDs. He cites the success of turtle excluder devices, in particular, as having heightening the interest in the use of BRDs. He concludes that few fundamental alternatives were explored in the analytical component of Amendment 9, with the exception of limited effort regimes (which he views as being presented as straw men) and closed seasons (see above). He expresses the concern that the investment in BRD technology has oriented discussion and behavior in the Gulf fisheries in such a way that reducing bycatch means using BRDs, even for those who really do not want to use them. He believes that even though the industry and public managers are poised to adopt Amendment 9, they should be aware that the benefit cost analyses are valid only in this context. He stresses that presently it is not known whether this solution is the best one, or the only one, that could have been devised.

Wilson discusses the possible refuge value of man-made and natural obstructions or hangs, which render ground "un-trawlable". He notes that there is some debate over the importance of assumed no-

trawl zones around hangs and reefs in the estimation of bycatch. Some industry members, for example, believe that bycatch calculations made by government scientists rely on assumed no-trawl zones which are smaller than those actually left by practicing fishermen. Fishermen argue that these unreasonable assumptions have increased bycatch estimates, making the problem seem more dire than it is in reality. Wilson believes that in reality it is not clear how much is really known about the behavior of fish or fishermen at a high spatial resolution. He suggests that the lack of environmental knowledge may be explained by insufficient economic incentives to surmount the barriers (and the costs) associated with acquiring high resolution or high definition data sets. He views this as having lead to the extensive use of inference and consequently analyses continue to be open to debate.

One of Wilson's suggestions for an alternative approach to the bycatch problem is the development of a bycatch minimization program based upon, for example, Global Positioning (GP) and Geographical Information Systems (GIS). This is envisaged as entailing within season mapping of bycatch "hot spots" to be avoided by the shrimp fleet and that it would be industry-organized and industry-run in response to their own economic interests. Such a system, he believes, would have knock-on advantages in terms of data collection and availability.

Wilson summarizes the written testimony on Amendment 9, most of which he notes was against it, but was mainly anecdotal in nature. Among others, he cites Swetman (1996), who argues that instead of a technological solution, marine sanctuaries and enhancement programs would be more cost effective. In conclusion, he encourages managers to think in terms of technologies which reduce transactions costs; and which can provide geographic information in real time, in order to take advantage, where possible, of the desire by most reasonable fishermen to avoid bycatch of non-target species.

In accordance with Wilson's report, Townsend describes the approach to bycatch reduction in the shrimp fishery as "command-and-control" or "technology-forcing", that is, government has developed technology in net design and has then mandated its adoption. As an alternative, he would prefer to see the placement of economic incentives on the shrimp industry to develop and utilize bycatch technology and believes this could be accomplished by a tax on bycatch that is set at the marginal damage done by bycatch. He also notes that if the cost of handling discarded fish is non-trivial, then there may already be some economic incentive for the industry to cooperate in bycatch reduction. He acknowledges that taxes may face serious enforcement problems, but considers that a theoretical analysis of their application is still important because it emphasizes the relation between incentives and technology and is in accordance with the current trend towards the adoption of incentive-based environmental regulation.

Bell suggests that an acceleration in imports prompted by aquaculture in South America and other parts of the world could reduce the bycatch of red snapper through the attrition of shrimp vessels from the industry. Bell says there is no evidence that this scenario was examined by the NMFS economists, but he believes it is worthy of consideration.

EXHIBIT C

HOOK, LINE, AND SINKING

The Crisis in Marine Fisheries

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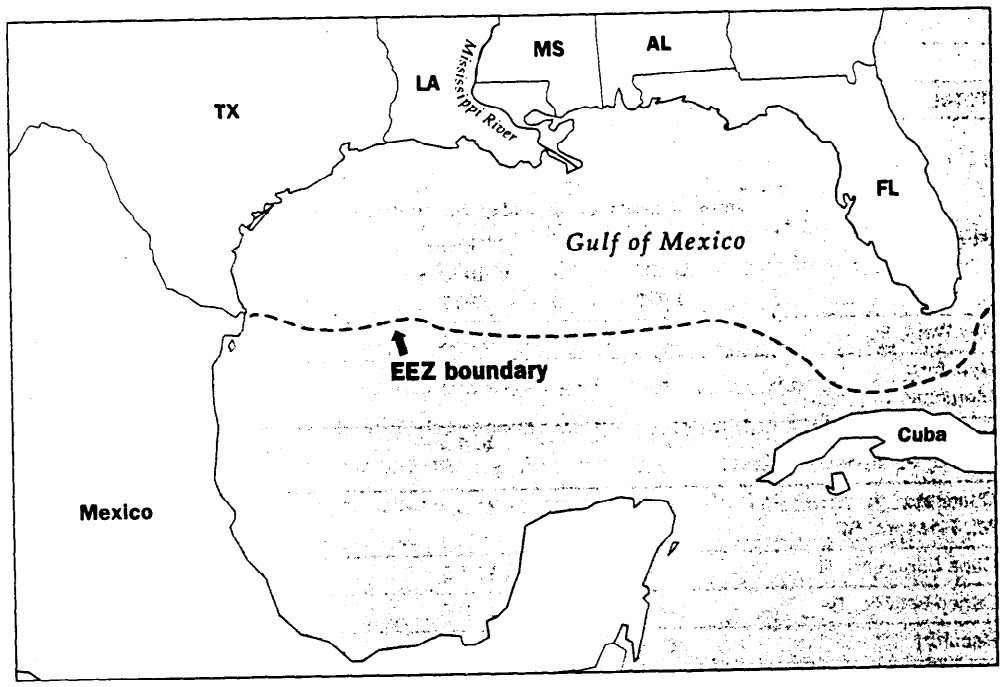
Natural Resources Defense Council/February 1997

GULF OF MEXICO

The Gulf of Mexico dominates the Southeast region's commercial fishing industry, generating 81 percent of its revenues,[312] which average over $750 million annually.[313]

Shrimp looms large in the Gulf, dominating commercial fishing revenues. The industry's high revenues, however, come at a significant environmental and economic



price. Bycatch of non-targeted species by shrimp trawlers is pervasive and affects many species of fish and other marine life in the region, including severely endangered sea turtles. Overfishing is also a problem in the Gulf, and although some over-exploited populations such as king and Spanish mackerel appear to be recovering, they remain stressed as a result of past overfishing.[314] Of fisheries in the Gulf whose status is known, red drum and red snapper are currently considered overfished.[315]

Recreational fishing is big business in the Gulf. Gulf anglers took 17 million trips in 1995 and landed more than one and a half times as many fish as anglers in any other region of the United States.

Habitat alteration, particularly in nearshore areas, threatens the health of all of the regions' fisheries. A full 98 percent of the commercially valuable species in the Gulf are estuarine dependent, and estuaries are bearing the brunt of the effects of industrial pollution, runoff, and development activities.[316] Runoff from much of the central United States flows into the Gulf of Mexico via the Mississippi River. Oil fields, refineries, and other heavy industry in the region contribute to pollution of sensitive coastal waters. Levee construction, water diversions, and canals destroy wetlands and restrict vital

Kirk Condyles/Impact Visuals

freshwater flow to coastal marshes and estuarine nurseries.[317] This in turn affects many of the region's most valuable fisheries, including shrimp.

Recreational fishing is a major industry in the Gulf. Gulf anglers took more than seventeen million fishing trips in 1995 and landed more than one and a half times as many fish as anglers in any other region of the United States.[318] Herring, spotted sea trout, catfishes, and pinfish accounted for about half the fish landed by recreational fishermen. The Gulf supports a very lucrative recreational fishing industry selling everything from boats, bait, and tackle to motel rooms.[319]

Shrimp

In 1995 alone, the Gulf shrimp fishing industry (excluding aquaculture) generated over $430 million in commercial sales and accounted for 60 percent of the Gulf's total commercial fishing revenue[320] and 72 percent of the nation's commercial shrimp catch.[321] Three species of shrimp—brown, white, and pink—constitute 91 percent of the commercial shrimp harvest in the Gulf.[322] Brown shrimp, which yield the most valuable catch, are primarily caught off the Texas-Louisiana coast while white shrimp are primarily caught off the Louisiana coast and pink shrimp off the southwestern coast of Florida.[323] Spawning by shrimp occurs offshore but the young move quickly inshore to estuaries where they develop as juveniles before moving back out to sea.[324] Juvenile shrimp survival depends on the extent of estuaries, fresh water flows into them and the temperature of their waters.[325] In recent years, rising sea level in the Gulf and coastal sinking has increased the spatial extent of estuarine areas and created more marsh edges in the northwestern coastal areas of the Gulf where brown shrimp feed. This expansion of feeding habitat is believed to be responsible for increased brown shrimp abundance. Scientists believe, however, that if this subsidence continues, it will ultimately diminish the abundance of shrimp and other commercial species as marshes deteriorate and wetlands are ultimately lost due to prolonged inundation.[326]

The shrimp industry has contributed to the depletion of some of the most endangered sea turtles in the world. Currently, only 700 to 800 female Kemp's ridley turtles nest along a limited portion of Mexico's Gulf coast.[327] In 1947, observers counted 40,000 of these turtles on a single day, on one beach alone.[328] The National Academy of Sciences estimated in 1990 that prior to the required use of "turtle excluder devices" (TEDs)—grates in the "neck" of trawler nets which allow large objects such as turtles to escape—the southeast shrimp industry killed as many as 44,000 turtles a year.[329]

The shrimp industry has contributed to the depletion of some of the most endangered sea turtles in the world.

While turtle deaths due to shrimp trawling have notably declined due to the mandatory use of TEDs, high mortality of turtles continues.[330] Conservation groups attribute this to lax enforcement in some areas, ineffective TED gear, exemptions from gear restrictions, and the lack of progress in restricting fishing effort and protecting critical habitat, including nearshore areas.

Bycatch in the shrimp industry extends beyond endangered sea turtles. Eighty percent of the catch taken by shrimp trawls consists of fish and other marine creatures

that are returned to the sea dead or dying.[331] Of this bycatch, 47 percent is finfish, comprised mainly of juveniles important to other valuable commercial fisheries.[332] In fact, for every pound of shrimp harvested, over four pounds of finfish are caught and discarded, usually dead or dying.[333] Yearly cumulative bycatch totals are staggering: 35 million red snapper, 5 million Spanish mackerel, 4.4 billion longspine porgy, and 13 billion Atlantic croaker.[334] Red snapper and Atlantic croaker are both overfished; bycatch of this magnitude contributes significantly to their depletion. Since 1986, the shrimp industry has incidentally captured 80-97 percent of the total annual catch of butterfish.[335]

To halt this wasteful practice, strong bycatch reduction measures are needed. One way to reduce bycatch is through the use of "bycatch reduction devices" (BRDs), which allow finfish to escape to varying extents from shrimp nets via enlarged mesh sizes or grates. The Gulf of Mexico Regional Fishery Management Council recently voted to require the use of BRDs on all shrimp trawls. This new regulation must be approved by the Secretary of Commerce and, if approved, is expected to be challenged in court by the shrimp industry.

Kirk Condyles/Impact Visuals

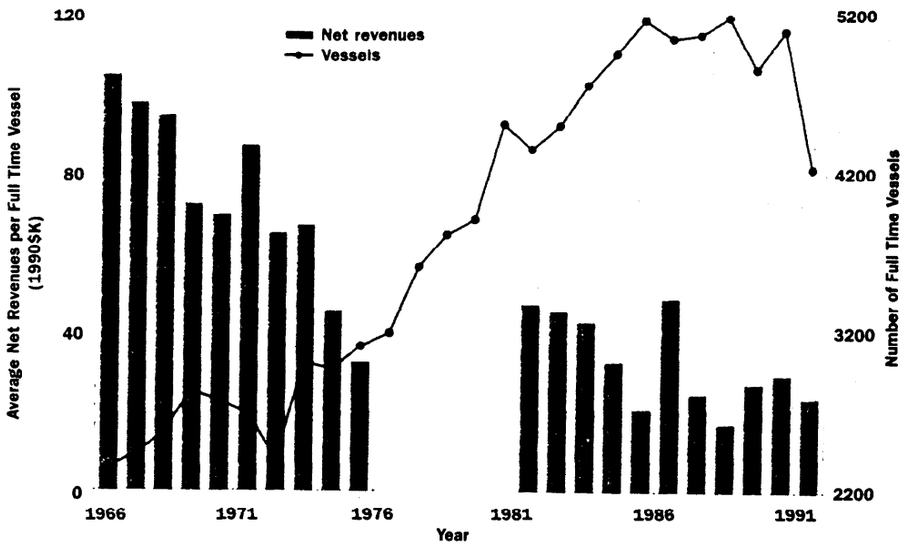
Seventy-two percent of the nation's shrimp is caught in the Gulf of Mexico by vessels like these. Bycatch in shrimp trawls is pervasive and affects many species of fish and other marine life, including endangered sea turtles.

The harmful impact of shrimp industry bycatch is compounded by overcapacity, as a grossly inflated fleet trawls the Gulf's waters, competing to gain larger portions of the available catch. The size of the Gulf fleet has increased dramatically since 1950[336] and several technological advances have enhanced the fleet's fishing capacity.[337] Typical modern shrimp vessels now drag four nets instead of two, as was common in the 1950s, horsepower has generally increased, and freezer vessels have replaced ice vessels, facilitating prolonged fishing ventures.[338]

According to NMFS, approximately one-half the fishing effort could yield the same catch.[339] Due to crowding, trawlers often drag their nets in less productive shrimp grounds that are equally or more productive for other species. As a result, increased effort does not result in a notably increased catch. Rather, increased capacity has resulted in a significant increase in bycatch, with only a slight increase in catch.[340]

Sensible and effective measures are needed to increase the industry's efficiency and reduce the fleet's overall size, and thereby reduce bycatch. The government has contributed to overcapitalization of the Gulf shrimp fleet by subsidizing shrimp vessel purchases for years.[341] These subsidies have been halted. Now, incentives are needed for fishermen to retire their boats permanently. License limitations and/or a boat buyout program to reduce the fleet along with mandatory use of bycatch reduction devices and enhanced monitoring would benefit endangered species and valuable finfish fisheries throughout the Gulf.

Figure 2-9. Overcapitalization of the Gulf Shrimp Fleet



Overcapitalization of the profitable Gulf of Mexico U.S. shrimp fishery: as the number of vessels rose, revenues per vessel dropped.

Source: NMFS, in press. *Our Living Oceans: The Economic Status of U.S. Fisheries, 1996.*

THE "BLACKENED REDFISH" CRAZE: GREAT FOR RESTAURANTS, BUT NOT FOR FISH

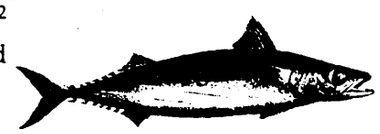
The red drum fishery has experienced various periods of intense exploitation over its recorded history (see the discussion of red drum in the South Atlantic section). In 1956, red drum landings peaked with the development of a pet food industry utilizing red drum along the northern Gulf of Mexico. Another intense period of exploitation followed in the 1980s when a new recipe, "blackened redfish," resulted in an exploding market for red drum.

Traditionally, red drum were harvested in inshore areas. With the advent of blackened redfish, adult red drum were fished in the Gulf in deep offshore waters for the first time. This shift resulted in intensive harvests, as the fish's schooling behavior facilitated capture with spotter planes and purse seines. Coupled with reductions in inshore recruitment that were possibly due to environmental changes and/or increased inshore fishing, offshore harvesting wreaked havoc on the red drum population. In response, the Gulf of Mexico Fishery Management Council banned offshore fishing and returned the fishery to its recreational tradition in inshore and coastal waters. Gulf states complemented the offshore fishing ban by imposing minimum size limits on retained fish, which allows more juvenile fish to mature to reproductive age. These measures appear to be aiding in the fish's recovery, although the population is still depleted and considered overfished by NMFS.

1066

King Mackerel

King mackerel once supported a heralded recreational and commercial fishery throughout the Southeast and the Gulf. The commercial fishery dates back to the 1800s and coexists with recreational fisheries along the northern Gulf, Texas, and Florida, where fishing for mackerel is centered.[342]



The National Marine Fisheries Service reported in 1995 that Gulf king mackerel was "severely depleted;" recent average annual abundance at this time was only approximately one-quarter of its maximum level despite conservation measures that had been in place for 10 years.[343] In the late 1970s and 1980s,[344] overfishing occurred in Florida and Louisiana where spawning female fish were believed to be residing.[345] This depletion is believed to have depressed the population into the 1990s.[346] Recent data and assessments indicate, however, that king mackerel has recovered significantly and is no longer considered overfished, although it remains below its full restoration target.[347]

Currently, both commercial and charter vessels must hold permits to fish for king mackerel as well as all other coastal pelagics (i.e., fish that live in open coastal waters—not on the sea bottom.) Both king and Spanish mackerel are under a management regime, established in 1985, that limits the commercial and recreational catch. Bycatch of both species in the shrimp fishery is high. In 1993, 650,000 juvenile king mackerel and 5 million juvenile Spanish mackerel were entrapped in Gulf shrimp nets.[348] Requiring BRDs in the Gulf shrimp fishery will undoubtedly help to further restore the king mackerel stock. In the directed fishery, recreational landings in particular must be controlled, since recreational fishermen consistently exceed their allocation of the total allowable catch.[349]

The Gillnet Ban

Many states, including Texas, Louisiana, and Florida, banned fishing by gillnets in state waters in the late 1980s and early 1990s. Gillnets are non-selective nets that entrap fish, typically by their gills, as well as other marine animals. Nets are left in the water and are checked routinely to remove captured fish.

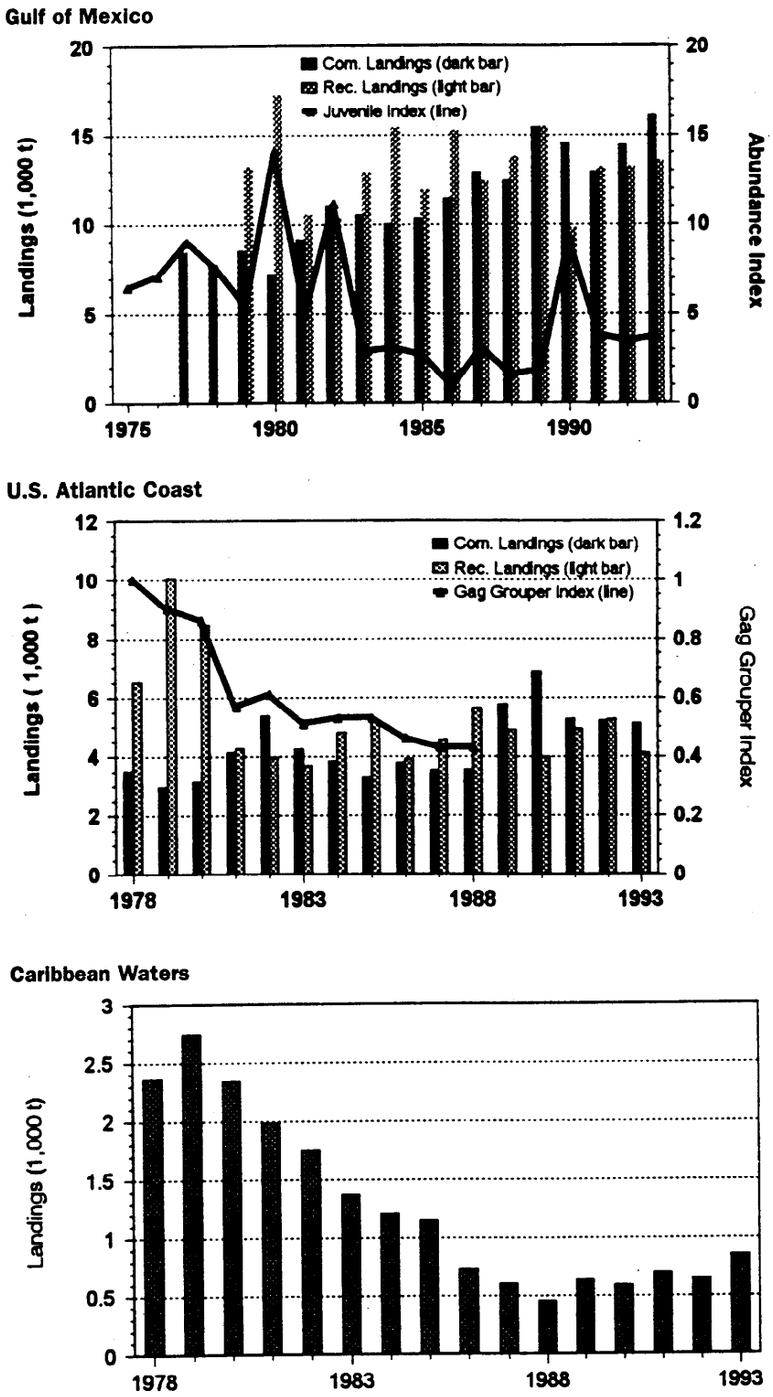
Gillnet bans have had the effect of displacing commercial fishermen and converting many traditionally commercial fisheries to recreational fisheries. Accordingly, the gillnet bans have disrupted some commercial markets for locally caught fish. In New Orleans, in particular, chefs have openly protested the Louisiana gillnet ban; they contend it has hindered their ability to serve local fish at competitive prices.[350]

Reef fish species are prone to overfishing if not carefully managed due to their easy capture and relatively advanced age of reproductive maturity.

Reef Fish

Reef fish species are prone to overfishing if not carefully managed due to their easy capture and relatively advanced age of reproductive maturity. Overfishing of reef fish reduces commercial and recreational opportunities and may threaten the ecological stability of the reef ecosystem. Reef species are believed to be highly

Figure 2-10. Reef Fish Trends in the Gulf, South Atlantic, and Caribbean



Reef fish in the Gulf, Caribbean, and South Atlantic have experienced varying declines over the past several decades. For many reef species, the status of the fishery is unknown.

Source: National Marine Fisheries Service

Degradation of coral reef ecosystems has important implications for tourism, especially in Florida and the Caribbean. The Florida Keys' natural resources alone, of which coral reefs and reef fish are an integral part, have been valued at almost $22 billion.

interdependent, such that exploitation or degradation of one inevitably affects others. For example, clownfish and sea anemones have a symbiotic relationship where the clownfish attracts predators which the sea anemone kills with its sting cells; both species then eat the prey.[351] Absent either species' presence, this mutually beneficial relationship would end and remaining populations could collapse.

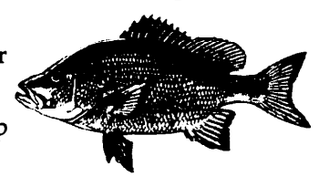
Recreational activities such as boating also endanger reef ecosystems due to physical damage (*e.g.*, anchoring of boats and collection of coral). Coral reefs depend on clear, unpolluted water; runoff and other sources of pollution pose major threats in many areas. Degradation of coral reef ecosystems has important implications for tourism, especially in Florida and the Caribbean. The Florida Keys' natural resources alone, of which coral reefs and reef fish are an integral part, have been valued at almost $22 billion.[352]

Management of reef fish suffers because of our lack of knowledge concerning their status (only 18 percent of reef species are of known status).[353] Adequate funding from federal and state agencies for research is unavailable principally because the commercial value of individual reef species is low even though their collective commercial and recreational value is high. In fact, reef fish in the Southeast are collectively valued at $48 million as a commercial fishery alone.[354] Such a myopic viewpoint disregards not only the local and regional economic importance of the recreational and commercial reef fish fishery, but also the significant tourism economies that reef fish support through sport fishing and diving.

Red Snapper

The red snapper stands out historically as the most important commercial reef fish in the Gulf of Mexico.[355] Commercial landings remained relatively stable in the 1960s to mid-70s but declined in the 1980s and 90s as fishing pressure increased.[356] Like other reef fish, red snapper are particularly vulnerable to overfishing as they are long-lived, slow growing, easy to capture, and reproduce at an advanced age.[357]

Red snapper was overfished throughout the 1980s in part due to bycatch in shrimp trawls, which continues to this day.[358] In the Gulf and elsewhere, shrimp trawlers' fine mesh nets trap juvenile red snapper, whereupon the fish are discarded at sea to make room on board for the more valuable shrimp.[359] In 1993, the estimated total number of red snapper discarded from the shrimp fishery was 34 million fish.[360] Meanwhile, the recent average annual catch of red snapper is only 3,215 metric tons, or roughly 3 million fish. Scientists believe a healthy fishery could produce 15,000 metric tons annually.[361]



Shrimp trawler bycatch of juvenile red snapper has prevented recovery of the species. Under current fishing conditions, only about 25 percent of juvenile red snappers reach sexual maturity due to shrimp fishery bycatch, significantly reducing the ability of the population to reproduce.[362] The Secretary of Commerce is currently considering requiring BRDs on all shrimp trawls to reduce finfish bycatch. NMFS has determined that a 50 percent reduction in shrimp trawl bycatch of juvenile red snapper is required for recovery of the red snapper population. With the potential

to reduce mortality of juvenile red snapper by 66 percent,[363] BRDs hold great potential to help restore the red snapper population.

FLORIDA BAY

Florida Bay, a shallow estuary at the southern tip of Florida, is a center of ecological productivity and biological diversity for the Gulf and the entire United States. At about 1350 square miles in total area with an average depth of less than three feet, Florida Bay is an invaluable resource for a multitude of species that spawn and feed in its biologically rich estuarine waters.[364] For example, the Bay is the center of stone crab production in the United States,[365] a fishery with recent annual revenues of $12–15 million.[366] Growth and survival of stone crabs depend upon the management of fresh water in the Everglades,[367] which flows to Florida Bay, moderates the Bay's salinity and temperature, and delivers nutrients.[368] Similarly, juvenile pink shrimp, spawned in the Dry Tortugas, develop in the Bay and depend upon fresh water flows from the mainland to ensure their survival.[369] In fact, NOAA is able to predict annual catches of pink shrimp based on fresh water flows over the past year.[370] Likewise, the health of many other ecologically and economically valuable fisheries, including spiny lobsters, has been linked to fresh water flows from the mainland.[371]

The health of Florida Bay has seriously declined over the last twenty years. In 1987, massive seagrass bed die-offs were first observed;[372] the die-offs were followed by widespread algal blooms and declining fish populations. Scientists believe these seagrass bed die-offs resulted in part from high salinity levels due to reduced fresh water flows from the mainland into the Bay.[373] Prolonged periods of high salinity levels are fatal to sea grasses. Die-offs not only destroyed the highly productive habitat that seagrasses provide, but also resulted in massive turbidity and the release of nutrients trapped in the roots of seagrasses. With little sunlight reaching beyond the water's surface and an overwhelming availability of nutrients, algal populations in the Bay exploded and further clouded the water, causing still more seagrass die-offs. This cycle continues to this day.

Algal blooms' cascading effects include habitat degradation and ecosystem decline which negatively affect the rich fishery resources of Florida Bay. For example, scientists believe that algal blooms are responsible for mass mortality of sponges and declines in the spiny lobster fishery, as juvenile lobsters depend upon sponges for shelter.[374] Furthermore, the loss of over 100,000 acres of seagrass beds has had implications for all of the Bay's juvenile fish and other marine species which utilize seagrass beds for feeding and protective cover.[375]

The loss of over 100,000 acres of seagrass beds has had implications for all of the Bay's juvenile fish and other marine species which utilize seagrass beds for feeding and protective cover.

A national scientific panel unanimously concluded in 1993 that reductions in fresh water flow to the Bay were partly responsible for the Bay's decline.[376] This reduction in flow is due to the water management practices of the Army Corps of Engineers, which diverts water for irrigation and shunts water off to the Atlantic and Gulf to provide flood protection to farms. Attempts to restore the Bay and remedy these detrimental management practices have been largely unsuccessful due to the opposition of agricultural interests throughout the Everglades, including powerful sugar farmers in the Everglades Agricultural Area.

Land acquisition funds made available in the 1996 Farm Bill should alleviate some stress on the water management system. These funds will permit the acquisition of wetlands in the Everglades that can restore water flows to some degree. However, water management in canals bordering Everglades National Park and its environs control the amount of water reaching Florida Bay, and water levels in these canals remain excessively low in order to drain nearby agricultural lands. Moreover, a vital restoration project that should provide increased structural capacity to convey water towards Florida Bay (the Modified Water Deliveries Project) is not scheduled to be in operation until 2012. In the meantime, scientific studies continue to affirm the Bay's ecological slide.

One recent study reveals the correlation between freshwater flows and prey fish abundance.[377] Prey fish numbers reflect general estuarine productivity. Prey fish are vitally important to predatory fish and crustaceans in the Bay and Gulf as well as to wading birds, including the endangered wood stork, and the endangered American crocodile. The wood stork and the crocodile are themselves widely recognized as excellent indicators of ecosystem health. These two species' continued depleted status signals the ongoing degradation of the entire ecosystem.

Spiny Lobster

Spiny lobsters are managed under a joint plan produced by the Gulf of Mexico and South Atlantic Fishery Management Councils. The plan is based on State of Florida regulations because almost the entire continental U.S. spiny lobster population is located off Florida. The fishery is lucrative, generating $20 million per year in commercial revenue in the Gulf and $2 million in the South Atlantic.[378]

In 1992, the spiny lobster fishery was significantly overcapitalized with 939,000 traps.[379] Florida estimated that the same yield could be obtained with half the number of traps and determined that excessive effort occurs whenever fishermen utilize over 300,000 traps.[380] Waste in the lobster fishery is exacerbated by the use of juvenile lobsters to bait traps. The State of Florida established a trap reduction program in 1993 which was extended into federal waters by the Regional Management Councils of the Gulf of Mexico and the South Atlantic. To limit the program's impact on fishermen, Florida capped trap reductions at 10 percent per year. In 1995, 674,000 traps were in Florida's waters, down 28 percent from 1992; landings appear stable in recent years at about 7 million pounds annually.[381] This success story provides valuable lessons for other stressed fisheries as phased reductions in fishing effort can not only benefit ecological resources, but also the fishermen who depend on them.

Table 2-6. GULF OF MEXICO FISHERIES, 1995

State	Commercial Landings 1995[a] Thousands of Pounds	Thousands of Dollars	Number of Fishing Vessels 1994[b]	Number of Processing Plants 1994[c]	Average Number of People Employed in Processing and Wholesaling 1994[d]
AL	28,741	$ 49,656	1,070	111	1,677
MS	145,468	$ 41,735	1,469	52	996
LA	1,110,220	$290,576	15,800	553	4,517
TX	94,674	$198,876	4,578	147	1,919
FL	133,483	$198,067	10,779	451	4,743
TOTAL	**1,512,586**	**$778,910**	**33,696**	**1,314**	**13,852**

Value of Landings, Selected Gulf of Mexico Ports[e]

Port	Rank in U.S. 1995	Millions of Dollars 1993	Millions of Dollars 1994	Millions of Dollars 1995
Dulac-Chauvin, LA	6	$48.0	$55.0	$53.4
Empire Venice, LA	7	$52.3	$60.1	$51.1
Bayou La Batre, AL	12	$24.3	$36.7	$37.5
Golden Meadow-Leeville, LA	16	$26.2	$30.1	$31.1
Cameron, LA	18	$27.4	$33.9	$27.8
Tampa Bay-St. Petersburg, FL	33	$19.6	$20.9	$18.2
Fort Meyers, FL	37	(na)	$23.5	$15.9
Appalachicola, FL	57	$ 7.9	$22.4	$10.2
Gulfport, MS	28	(na)	$18.2	$23.3
Grand Isle, LA	34	$13.5	$12.1	$17.8
Delcambre, LA	38	$12.8	$18.9	$15.5

[a] NMFS, 1996. *Fisheries of the United States, 1995*, p. 4.
[b] *Id.*, p. 88.
[c] *Id.*, p. 89.
[d] *Id.*
[e] *Id.*, p. 5.

Table 2-7. SOUTH ATLANTIC, GULF, AND CARIBBEAN FISHERIES, 1995

	Abundance[a]	Level of Exploitation[a]	Recreational Catch 1987–1992 1,000 metric tons[b]	Commercial Catch Foreign and Domestic 1989–1993 1,000 metric tons[b]
Coastal Pelagics				
King Mackerel				
Gulf of Mexico	Low	overexploited	(1992) 2.6	(1992) 1.6
South Atlantic	Medium	less than fully exploited	(1992) 2.2	(1992) 1.0
Spanish Mackerel				
Gulf of Mexico	Medium	fully exploited	(1992) 1.2	(1992) 1.3
South Atlantic	Medium	fully exploited	(1992) 0.9	(1992) 1.7
Dolphinfish	Unknown	unknown	(1992) 3.9	(1992) 0.7
Cobia	Unknown	unknown	(1992) 1.0	(1992) 0.2
Reef Fish				
Red Snapper	Low	overexploited	(1987) 0.7[c]	(1989) 1.3[d]
Vermilion Snapper (South Atlantic)	Low	overexploited	*	(1991–1993) 0.7[e]
Red Grouper (Gulf of Mexico)	Medium	fully exploited	(1990–1992) 1.1[f]	(1990–1992) 2.7[g]
Wreckfish (South Atlantic)	Medium	fully exploited	*	(1994) 0.6[h]
Other Snappers				
South Atlantic	Low	overexploited	*	(1991–1993) 0.9[i]
Gulf of Mexico	Unknown	unknown	*	(1991–1993) 5.1[i]
Red Porgy (South Atlantic)	Low	overexploited	(1990) 0.02	(1992) 0.1[j]
Other Porgies	Unknown	unknown	*	(1991–1993) 0.2[i]
Other Fish				
Menhaden	Medium	fully exploited	Unknown[k]	(1993) 859.9
Black Drum	Unknown	unknown	*	(1991–1993) 2.6[i]
Red Drum	Low	overexploited	(1990) 2.7	(1990) 0.09
Seatrouts	Low	unknown	*	(1991–1993) 10.6[i]
Atlantic Croaker	Low	overexploited	*	(1991–1993) 2.3[i]
Gulf Butterfish	Medium[l]	fully exploited[m]	*	(1991) 20.0[n]
Shrimp and Other Invertebrates				
Brown Shrimp	Medium	fully exploited	*	(1991–1993) 57.8[i]
White Shrimp	Medium	fully exploited	*	(1991–1993) 37.1[i]
Pink Shrimp				
South Atlantic	Low	fully exploited	*	(1991–1993) 0.7[i]
Gulf of Mexico	Medium	fully exploited	*	(1991–1993) 5.4[i]
Seabob Shrimp	Unknown	unknown	*	(1991–1993) 4.4[i]
Spiny Lobster				
Southeast	Low	overexploited	(1992) 0.7	(1992) 2.5
Caribbean	Unknown	unknown	*	(1991–1993) 0.1[i]
Stone Crab	Medium	fully exploited	*	(1991–1993) 1.3[i]

* The recreational catch is included in the commercial catch figures. NMFS does not separate out recreational catch for the species.

[a] Unless otherwise noted, abundance and level of exploitation are derived from NMFS, 1996, *Our Living Oceans, 1995* and refer to both the South Atlantic and Gulf of Mexico. Abundance is derived from NMFS' comparison of recent estimated stock level to the biomass that on average would sustain long-term potential yield; low, medium, and high abundance in these tables correspond to NMFS' terms, "below," "near" and "above" for long-term potential yield. Our use of NMFS' assessments of abundance and exploitation levels does not necessarily imply our agreement with those assessments.

[b] Unless otherwise noted, recreational and commercial catch totals are derived from NMFS, 1993. *Status of Fishery Resources Off the Southeastern United States for 1993.* Our use of NMFS' assessments of abundance and exploitation levels does not necessarily imply our agreement with those assessments.

[c] This figure does not include South Atlantic landings, which in 1991–1993 comprised only 7% of the total combined commercial and recreational catch for the entire Southeast.

[d] *Id.*

[e] This figure combines the average commercial and recreational landings in the South Atlantic for 1991–1993 from NMFS, 1996. *Our Living Oceans, 1995.*

[f] *Id.* This figure assumes 29% of the total harvest of 3,862 tons was recreational as outlined in NMFS, 1993. *Status of Fishery Resources of the Southeastern United States for 1993.*

[g] *Id.*

[h] This figure includes all catch from the ITQ system for the South Atlantic wreckfish fishery.

[i] This figure combines the average commercial and recreational landings in the South Atlantic and Gulf of Mexico for 1919–1993 from NMFS, 1996. *Our Living Oceans, 1995.*

[j] This figure includes only data from North Carolina and South Carolina where 95% of red porgy in the South Atlantic is caught.

[k] See NMFS, 1993. *Status of Fishery Resources of the Southeastern United States for 1993,* p.p. 54 and 55.

[l] The abundance and level of exploitation determinations are derived from NMFS, 1994, *Our Living Oceans, 1993.*

[m] *Id.*

[n] This figure represents all catch of Gulf Butterfish landed in the South Atlantic and the Gulf of Mexico in 1991, including recreational.

EXHIBIT D

Gulf of Mexico Fishery Management Council

A Perspective on Fishery Science

by Albert King, Sr. (retired commercial fisherman)

A statement presented to the Gulf of Mexico Fishery Management Council's Scientific and Statistical Panel (SSC) on September 10, 1998

My intent is not to criticize the individual scientists of NMFS but the policy of the agency. I do intend to jog the conscience of all who should ask the correct questions about the proper use of data. I want to remind each of us how our silence or consent about the use of biased data and how this action has a tremendous impact on options and outcomes of management. Please don't forget that we don't make decisions on the fish. We make them on the people who fish. A wise man once said, "Rebuke a wise man and he love's you for it, rebuke a fool and he'll hate you;" therefore, I know everyone will appreciate what I have to offer.

One of the accepted definitions of the word "perspective" is: " the capacity to view things in their true relations or relative importance." This is the context of how I try to use fishery science in my management responsibilities. I cannot accept assumptions in stock assessments when it will change the "true relations and relative importance" because it covers needed unknown facts. This is what I feel has happened.

I hope this SSC will find the need to review the entire stock assessment procedures used in the management of fish stocks in the Gulf of Mexico. The "relative importance" of truth in these stock assessments is not in the credibility of the model or the reputation of the modeler. It should be the fact that the stock of fish in the assessment is relative and comparable to that which exists in the water. When the historical professional fishermen, both charter boat and commercial, tell you that there are vast differences from what the model shows, we must listen to those who see and catch the fish daily. A fisherman operates in a world of facts and truth. He can't sell the fishing experience or the fish he caught yesterday or the prediction of better times tomorrow, to the paying customer of today. When he drops down the line or net and comes up with fish more frequently and of a greater size, he cannot accept the paper predictions of the model stating doom, gloom and over fished. Many were present twenty years ago when the 200-mile limit changed the way fisheries were prosecuted. These fishermen are the one's with the most "relative importance." They experienced what too many boats in too small an area could do to the fish stocks and their way of life. They have suffered the pain but receive no gain when a fish stock rebounds. They should not have to go to the courts or Congress to get increases in fish quotas. It should not be possible for biased data to control the lives of so many hard working and tax paying citizens. Bad data should not give credibility to the radical cry of "rape and pillage of the resource." These accusations are the results of erroneous, politically motivated, stock assessments being used as "the best available science" in management issues. Red drum allocation is a good example of this action in use. The Louisiana net ban is an example of how it is ignored when it doesn't fit their need.

The use of spawning potential ratio (SPR) as the criteria for measuring conditions of a stock is very arbitrary and is filled with far too many unknowns and assumptions. This stock measurement criterion is nothing more than a ***subjective hypothesis***. The SPR percentage can have a range from 5% to 40% as a definition for stock conditions; however we receive recommendations always in the 20% and 30% range for most all species under management. NMFS uses these percentages as though they are scientifically

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sound finite numbers. The truth is one can speculate between a low of 6% to a high of 20% if certain data points are accepted. I have not heard of an un-fished stock of fish which could be used to verify the truth of any SPR ratio.

The red snapper stock assessment is the prime example of failure in NMFS stock assessments. It seems impossible to correct errors in assessments because assumptions can be used as science to reach political goals and agendas. These assumptions create an *illusion of truth* and it is then substituted for facts and used as "the best available science." There may be nothing wrong with the belief that SPR could be used as a measure of stock conditions if the data is unbiased and approved as being scientifically valid before it is used. The facts are that we have put thousands of fishing families at risk of bankruptcy and poverty by using biased data. This act is unconscionable especially when the explanation for flawed science is to "err toward conservation." This has been the explanation I have received when I ask; "Why is this specific number used for natural mortality when another number could be used?" Numbers are extrapolated from flawed data sets such as the shrimp effort from landings without interviews. Another example is red snapper recruitment coming from otter trawl sampling from over mud bottom when the animals are not in their natural habitat. You cannot drag an otter trawl over and through obstructions where thered snapper congregate. I don't have to be a population dynamics modeler or rocket scientist to know the assessments using this biased data is wrong.

Landings could and should be divided by effort to obtain the CPUE of a fishery. This requires data sets that are unbiased and representative of the actions in the fisheries. NMFS port agents were allowed to substitute their opinions for the grid and depth zone fished for many of the landings where interviews did not take place. When NMFS allowed their port agents to substitute their unqualified opinions for interviews with boat captains and mixed them with the interviewed data, they created a biased and completely unreliable, counterproductive data set. This one action has biased the CPUE and shrimp effort from the shrimp landings. It presents the opportunity for anyone stratifying data to place other catch locations or time fished to the landing data. When the shrimp effort is biased, the bycatch estimates are also biased. The time fished is the most critical element in calculating CPUE and effort from landings. The total fishing effort in the shrimp trawl fishery is the primary factor in estimating bycatch of juvenile red snapper. NMFS red snapper stock assessments state that the shrimp trawl fishery accounts for over 80% of the mortality of juvenile red snapper before they recruit to the fishery. Why should the red snapper fishermen and shrimpers pay the penalty for improper protocols in data collections by NMFS? This action might help further the political goals of the agency or the self- serving needs in different departments but it should not be used to create chaos in the lives of the people dependent on good data to keep working. NMFS is well aware of this fact because I have made it known countless times during various workshops and meetings. Mv frustration is compounded when the scientific community ignores these acts by refusing to tell NMFS that it could or should not use this data as "the best available science" as defined by the Magnuson Stevens Act. This data set is referenced as being a problem by the peer reviewers mandated by Congress but is still used because it is in the only data set available for landings during the time series of the eighties and early nineties. The landing data might be good but the CPUE and effort for this critical time- series is nothing more than a ***hypothetical illusion***. Now you see why I referenced NMFS fishery science as "smoke and mirror science" because it gives "the illusion of truth to the uninformed" If you members of the SSC continue to accept flawed science coming from flawed data, these half-truths will continue to dominate the lives of the fishermen and the management measures.. We on the council depend on the SSC for their credibility in judging competent fishery science. When there is a failure here, I believe the complete council process is a failure.

I can speculate why fishery science in NMFS left the objective reality in biology and joined the subjective statistical society of population dynamics modeling. The former had to meet the test of facts and/or results and the latter could escape from these restraints. Finding the motive for why can usually the traced

by following the money trail. Philanthropy, foundations and government grants supply the money. while government bureaucrats, academia and the environmentalists supply the credibility. Opportunities are recognized for desires, beliefs and emotions to serve as proxies for truth if the money is there for the research and career opportunities. Statistics from polls and surveys can be are used in models to shroud these ulterior motives. especially, if it helps the environmental communities preservation concept to stay hidden behind the banner of science and conservation. As long as hypothetical science is accepted as" the best available science" it will serve the greed and political needs of those in power. The biased "best available science" will be conveyed to the populace by a friendly press who has a need for sensational news of over fishing, by-catch and preservation disguised a s conservation. All "relative importance" toward truth will continue to subjective to the self-serving motives of all the participants.

I look upon the SSC as a jury on science who must satisfy their minds that good basic science is the ***only*** "best available science." The best available science does not have to always come from NMFS but it should always be the paradigm for truth. I have heard and read of biased data being questioned in discussions by members of the SSC but their concerns are usually overwhelmed by self-serving individuals protecting credibility of NMFS science while looking for grants or promotions in academia or government. The **only** available science should not always be rubber stamped as being the best. I am waiting for some statement from the SSC which says. "I don't have enough unbiased data to make an unbiased decision." Such a statement might send a message that truth and fact is a priority. It might also help to end the era of fishery science being used to gain political favor for state fishery policies in the council process.

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