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National Marine Fisheries Service
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August 12, 2009 F/SEC2: TJ

MEMORANDUM TO: Roy Crabtree, Ph.D.
Regional Administrator, Southeast Regional Office

FROM: Bonnie Ponwith, Ph.D. Theo R. Brainerd
Science Director, Southeast Fisheries Science Center

SUBJECT: Data Analyses for Amendment 17A and 17B to the South Atlantic Snapper Grouper Fishery Management Plan

Enclosed are the Southeast Fisheries Science Center data analyses for actions being considered in Amendments 17A and 17B of the South Atlantic Fishery Management Council.

For Amendment 17A, the following red snapper analyses were conducted and contained in the attached files, "**Red Snapper Projections Revised VI**" and "**Red Snapper Projections VII**":

(1) Suite of projections with "high" recruitment in 2005-2006;
(2) Projection that rebuilds in 35 years;
(3) Suite of projections using F30%;
(4) Yield at F45%.

For Amendment 17B, the following analyses were conducted and contained in the attached files, "**Average Weight of tilefish (*Lopholatilus chamaeleonticeps*) in recreational landings**" and "**P* Tables for Gag, *Mycteroperca microlepis*, off the Southeastern United States**":

(5) Identify conversion factor for landings of tilefish;
(6) Gag grouper P* tables.

You may contact Erik Williams at (252) 728-8603 or Erik.Williams@noaa.gov if you have any questions or clarifications.

Cc: F/SEC – Theo Brainerd
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Average weight of tilefish (*Lopholatilus chamaeleonticeps*) in recreational landings

Sustainable Fisheries Branch, SEFSC-Beaufort
31 July 2009

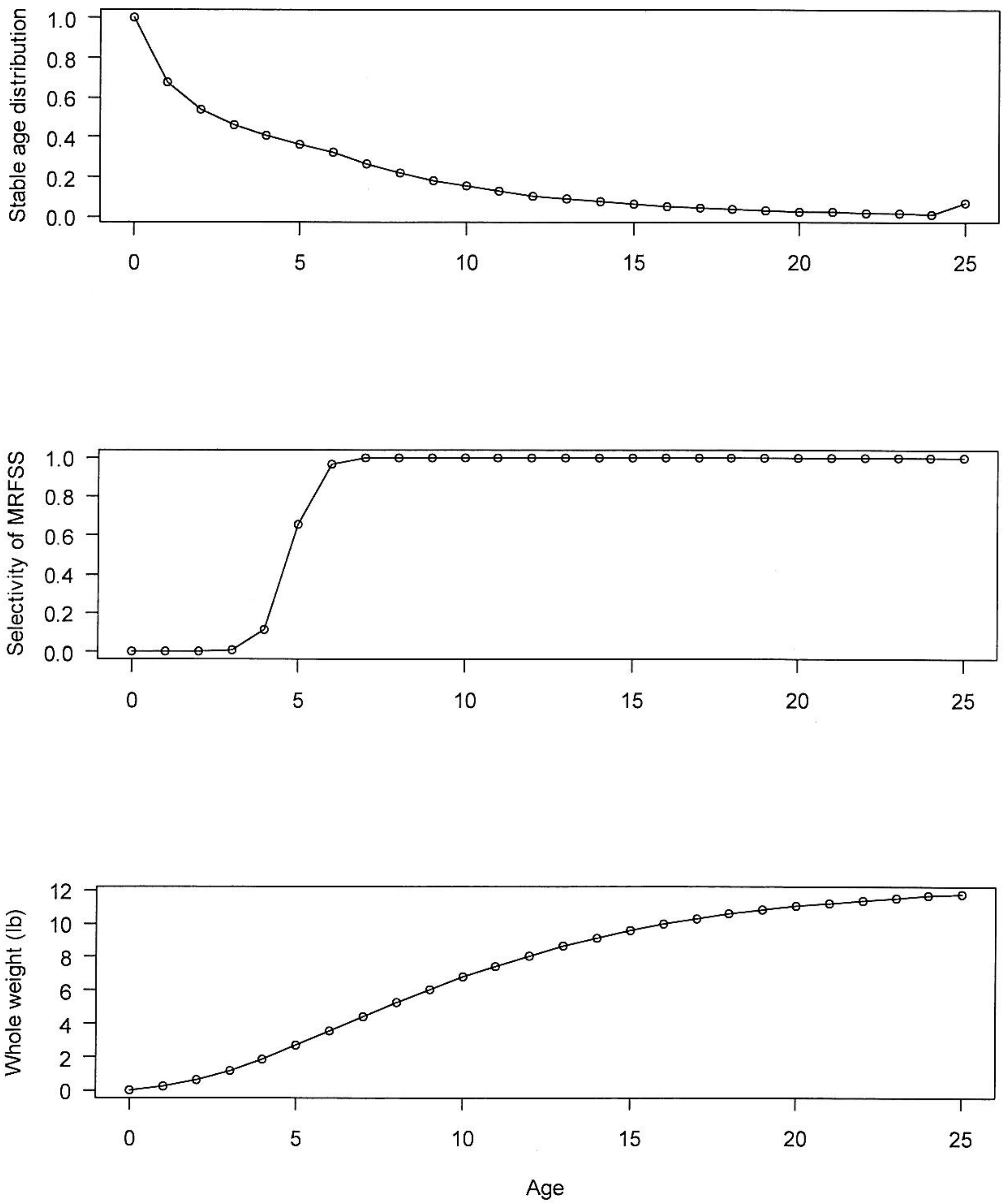
In a memorandum dated 10 July 2009, from Dr. Crabtree to Dr. Ponwith, SERO requested that the SEFSC provide a conversion factor for tilefish to convert recreational landings in weight to landings in numbers. This document provides that conversion factor and describes the methods used to compute it.

The conversion factor was computed using results from the SEDAR-4 benchmark assessment of tilefish. That assessment applied a mixed Monte Carlo and bootstrap procedure, which included many model runs. The run used here was the primary run (labeled "initial run" in the assessment report). From the initial run, we applied the stable age distribution (N_a), selectivity at age of MRFSS (s_a), and average whole weight at age (w_a) (Figure 1). The stable age distribution was computed using the total mortality at age averaged over the last five years of the assessment (1998–2002), and it treated the oldest age as a plus-group. The mean weight (μ_L) of fish landed by MRFSS was then calculated as,

$$\mu_L = \frac{\sum_a (N_a s_a w_a)}{\sum_a (N_a s_a)}$$

This resulted in an average weight of 6.21 lb whole weight per fish. Thus, to convert landings in pounds of whole weight to landings in numbers, one should divide landings (pounds whole weight) by 6.21.

Figure 1. Tilefish stable age distribution (top), selectivity of MRFSS (middle), and mean weight at age (bottom).



P* Tables for
Gag, *Mycteroperca microlepis*, off the Southeastern United States

Last modified: August 14, 2009

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1. Introduction

To help guide management decisions, this preliminary report offers a method to compute annual catch limits (ACLs) of gag off the southeastern United States. Because ACLs are a new requirement under the reauthorized Magnuson–Stevens Fishery Conservation and Management Act (MSFCMA), a body of practice does not yet exist on implementation. We describe a probability-based approach to compute ACLs that maintains a low probability of overfishing, which is the intent of the new requirement, and accommodates uncertainty in both stock dynamics and assessment results. The method is based on the REPAST approach to setting target reference points (Prager et al. 2003), but considerably revised to (1) establish reference points in catch, not fishing mortality rate, and (2) add a stock-projection component, which is needed to set catch for more than one year following a stock assessment.

As of the date of this report, ACLs are not clearly defined. In fact, they have yet to be specified as either a target or a limit. In this report, they are treated as a target. However, the methods could still apply if ACLs were specified as a limit simply by changing terminology.

This preliminary report is not intended to propose actual ACLs of any stock, although the method is illustrated with an application to gag grouper. The purpose of this preliminary report is to provide the SSC a chance to review the method and application. If the method is found acceptable, suggested improvements could be incorporated into a subsequent report, which would be made available for review at a future SSC meeting. The subsequent report would propose actual ACLs for management of gag.

2. Methods

Given the uncertainties in fishery management and science, it is arguably impossible to fish without at least some risk of overfishing. Rather than attempt to achieve zero probability of overfishing, we describe a method whose goal is to keep the probability of overfishing in any year below a preset value (e.g., 0.1), thus satisfying the new requirement of the MSFCMA. The method is general, but can incorporate details of almost any stock previously subjected to assessment, in this case, gag off the southeastern US.

2.1 A probability-based approach to setting catch limits (PASCL)

Our proposed method is a probability-based approach to setting catch limits (PASCL). It acts as a control rule, incorporating uncertainties in assessment results and in future stock dynamics. Given these uncertainties, PASCL sets annual levels of catch consistent with the risk of overfishing considered acceptable by managers.

Uncertainty in assessment results is standard output of most stock assessments, for example, through Bayesian or bootstrap approaches. For use in PASCL, the key assessment result is uncertainty in the limit reference point (LRP) of fishing mortality rate (*F*). Characterizing such uncertainty is quite flexible in PASCL; it can be described by any appropriate probability density function, whether parametric (e.g., normal, lognormal) or nonparametric (e.g., empirical, kernel density estimate). Where a distribution is unavailable, PASCL could utilize a single point estimate; however, we do not recommend this approach as it ignores uncertainty in assessment results.

Uncertainty in stock dynamics is described by a stochastic projection model. The projection not only allows setting ACLs for more than a single year, but also accounts for the inevitable lag between final year of assessment data and first year of ACL implementation. The projection model can include any source of uncertainty deemed appropriate, no different from other projection models used currently for fishery management. Sources often considered are recruitment dynamics and initial number at age.

In PASCL, as in REPAST (Prager et al. 2003), the level of risk acceptable to managers is quantified and transparent. Here we define *risk* as the probability (P^*) that F in any given year exceeds its LRP. A small value of P^* would imply risk-averse management, and a large value would imply risk-prone management. Either way, P^* should be less than 0.5, as $P^*=0.5$ would, in effect, treat the limit as a target, with overfishing expected in half of all years.

If the LRP is fixed (i.e., a point estimate), P^* in year t depends only on the probability density function (ϕ_{F_t}) of F_t:

$$P^* = \Pr(F_t > F_{LRP}) = \int_{F_{LRP}}^{\infty} \phi_{F_t}(F)dF = 1 - \Phi_{F_t}(F_{LRP}) \qquad (1)$$

where $\Phi_{F_t}(F_{LRP})$ is the cumulative density function of F_t evaluated at the limit F_{LRP}. If the LRP is uncertain, described by its own probability density function ($\phi_{F_{LRP}}$), P^* is computed from the following:

$$P^* = \Pr(F_t > F_{LRP}) = \int_{0}^{\infty} \left[1 - \Phi_{F_t}(F)\right] \phi_{F_{LRP}}(F)dF \qquad (2)$$

In essence, Equation 2 is the weighted sum of probabilities computed through Equation 1, for all possible values of F_{LRP}. Because P^* is defined as an annual probability, the risk of overfishing in at least one year grows as the time horizon is extended (Figure 1).

The goal of PASCL is to set the ACL such that the realized P^* equals the desired P^*. This can be achieved through projection (Figure 2):

1) For each of N replicates of the stock, compute F_t that yields a fixed catch C. This will produce N values of F_t, which can be used to define its probability density (ϕ_{F_t}).
2) Given ϕ_{F_t} and the probability density of F_{LRP} ($\phi_{F_{LRP}}$), compute the realized P^* according to Equation 2.
3) Adjust C until the realized P^* equals the desired P^*, which could be accomplished with an optimization routine. This C is the ACL.
4) Project each replicate one year forward with its F_t that provides the ACL.
5) Repeat for T years.

The needed duration (T) of the projection will vary from stock to stock, but should extend at least until ACLs based on the next scheduled assessment could be implemented.

2.2 Application to gag

Gag was most recently assessed in 2006 using data through 2004 (SEDAR 2006). The assessment had two base models that differed regarding their assumptions about catchability in fishery-dependent indices of abundance. One model assumed that catchability has remained constant over the past several decades; the other assumed that catchability has increased with improved technology and gear. In this application, we used the model with constant catchability to remain consistent with the recommendation of the SEDAR review panel. Although that panel acknowledged a likely increase in catchability over time, the rate of increase remains an open question, and thus the panel recommended adopting the status quo of constant catchability.

Implementation of PASCL requires probability densities of the limit reference point and of the fishing rates that achieve ACLs. The LRP of F was based on F_{MSY}, the fishing rate at maximum sustainable yield (*MSY*). In this application, as in the assessment, the probability density of F_{MSY} ($\phi_{F_{MSY}}$) was estimated from values that were generated by empirical bootstrap of the Beverton–Holt spawner-recruit curve (Figure 3). The probability density of F_t (ϕ_{F_t}) was estimated from values that were generated by a stochastic projection model with $n=2000$ replicates. Both densities ($\phi_{F_{MSY}}$, ϕ_{F_t}) were quantified nonparametrically using kernel density estimation with a Gaussian kernel and bandwidth equal to that kernel's standard deviation (Venables and Ripley 2002).

The projection model was identical to the age-structured assessment model, and parameter values were those used or estimated in the assessment (SEDAR 2006). The projection included two sources of uncertainty in stock dynamics. One was uncertainty in recruitment, which was assumed to follow the lognormal distribution of error estimated in the assessment. The other was uncertainty in initial number at age. The assessment provided only point estimates of number at age in 2005, the first year of projection; to add uncertainty, we assumed the initial number at each age followed a lognormal distribution with standard deviation equal to that of recruitment and mean equal to the point estimate. This approach accounts for uncertainty in the initial conditions, while maintaining any strong year classes estimated in the last year of the assessment.

The projection started in 2005, yet ACLs would not likely be implemented until 2008. To project the stock through this initialization period (2005–2007), we applied a fixed F set at the geometric mean of values estimated by the assessment for 2002–2004. The duration of projection was set to 10 years, which included three years of initialization followed by seven years of ACLs.

PASCL requires as input the quantified risk of overfishing. This allows managers to acknowledge such risk explicitly and to decide on a level considered acceptable. To help guide that decision, we present ACLs computed from six values of P^*: 0.10–0.35, in increments of 0.05.

3. Results

For any level of catch, the $n=2000$ projection replicates produced $n=2000$ values of F_t, because stock structure (number at age) varied stochastically among the replicates. The ACLs were set by adjusting catch until the values of F_t provided the desired P^* (example in Figure 4).

By definition, *P** quantifies the acceptable risk of overfishing. In general, a higher *P** led to larger ACLs (Tables 1–6). It also led to more dead discards and smaller spawning stock biomass (SSB). Ultimately, the choice of *P** is a management decision.

References

Prager, M. H., C. E. Porch, K. W. Shertzer, and J. F. Caddy. 2003. Targets and limits for management of fisheries: a simple probability-based approach. N. Am. J. Fish. Manag. 23:349–361.

SEDAR. 2006. SEDAR 10 Stock Assessment Report 1: South Atlantic Gag Grouper. South Atlantic Fishery Management Council. Charleston, SC.

Venables, W. N. and B. D. Ripley. 2002. *Modern Applied Statistics with S.* New York: Springer.

Table 1. Projection with annual probability of overfishing *P*=0.10*.

Yr	**SSB (1000 lb)**	**Recruits (1000s)**	**F(/yr)**	**Landings (1000 lb)**	**Dead Discards (1000s)**	**Dead Discards (1000 lb)**
2005	8033	455	0.31	1574	23	114
2006	7356	457	0.31	1542	21	88
2007	6472	459	0.31	1387	25	98
2008	5928	446	0.15	628	14	56
2009	6475	453	0.15	651	15	64
2010	7092	450	0.15	686	15	65
2011	7680	452	0.14	737	14	64
2012	8234	448	0.14	797	14	64
2013	8759	457	0.14	852	14	63
2014	9208	465	0.14	898	14	63

Table 2. Projection with annual probability of overfishing *P*=0.15*.

Yr	**SSB (1000 lb)**	**Recruits (1000s)**	**F(/yr)**	**Landings (1000 lb)**	**Dead Discards (1000s)**	**Dead Discards (1000 lb)**
2005	8033	455	0.31	1574	23	114
2006	7356	457	0.31	1542	21	88
2007	6472	459	0.31	1387	25	98
2008	5928	446	0.16	676	15	61
2009	6420	453	0.16	693	16	68
2010	6984	450	0.16	725	16	70
2011	7531	452	0.15	775	15	69
2012	8033	448	0.15	835	15	68
2013	8511	456	0.15	888	15	68
2014	8923	464	0.15	932	15	68

Table 3. Projection with annual probability of overfishing *P*=0.20*.

Yr	**SSB (1000 lb)**	**Recruits (1000s)**	**F(/yr)**	**Landings (1000 lb)**	**Dead Discards (1000s)**	**Dead Discards (1000 lb)**
2005	8033	455	0.31	1574	23	114
2006	7356	457	0.31	1542	21	88
2007	6472	459	0.31	1387	25	98
2008	5928	446	0.17	715	16	64
2009	6375	453	0.17	727	17	72
2010	6898	449	0.17	755	17	74
2011	7410	452	0.16	804	16	73
2012	7873	447	0.16	863	16	72
2013	8319	456	0.16	916	16	72
2014	8696	464	0.16	957	16	71

Table 4. Projection with annual probability of overfishing *P*=0.25*.

Yr	SSB (1000 lb)	Recruits (1000s)	F(/yr)	Landings (1000 lb)	Dead Discards (1000s)	Dead Discards (1000 lb)
2005	8033	455	0.31	1574	23	114
2006	7356	457	0.31	1542	21	88
2007	6472	459	0.31	1387	25	98
2008	5928	446	0.18	749	17	68
2009	6336	453	0.18	755	17	76
2010	6828	449	0.18	782	17	77
2011	7306	452	0.17	830	17	76
2012	7739	447	0.17	889	17	76
2013	8147	455	0.17	940	17	75
2014	8493	463	0.17	980	17	75

Table 5. Projection with annual probability of overfishing $P^*=0.30$.

Yr	**SSB (1000 lb)**	**Recruits (1000s)**	**F(/yr)**	**Landings (1000 lb)**	**Dead Discards (1000s)**	**Dead Discards (1000 lb)**
2005	8033	455	0.31	1574	23	114
2006	7356	457	0.31	1542	21	88
2007	6472	459	0.31	1387	25	98
2008	5928	446	0.19	778	17	70
2009	6302	453	0.19	781	18	79
2010	6762	449	0.18	805	18	80
2011	7213	451	0.18	854	18	79
2012	7615	447	0.18	914	18	79
2013	7996	455	0.18	963	18	79
2014	8308	463	0.18	1002	18	78

Table 6. Projection with annual probability of overfishing $P^*=0.35$.

Yr	**SSB (1000 lb)**	**Recruits (1000s)**	**F(/yr)**	**Landings (1000 lb)**	**Dead Discards (1000s)**	**Dead Discards (1000 lb)**
2005	8033	455	0.31	1574	23	114
2006	7356	457	0.31	1542	21	88
2007	6472	459	0.31	1387	25	98
2008	5928	446	0.20	805	18	73
2009	6272	453	0.19	804	19	82
2010	6704	449	0.19	827	19	83
2011	7127	451	0.19	876	19	82
2012	7501	446	0.19	937	19	82
2013	7856	455	0.19	985	18	82
2014	8140	462	0.19	1022	18	81

Figure 1. Risk of overfishing extended across years, calculated as the probability of overfishing in at least one year as a function of the annual risk P^*, assuming independence among years.

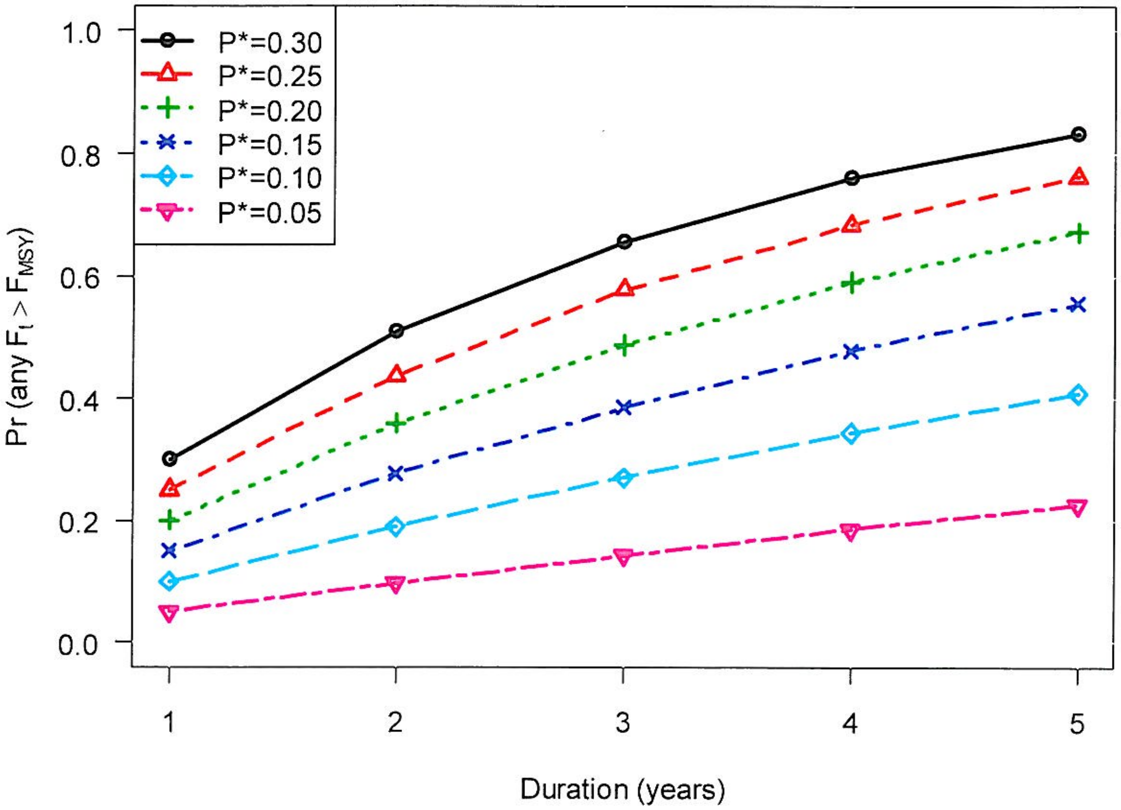


Figure 2. Flowchart of method to compute ACLs.

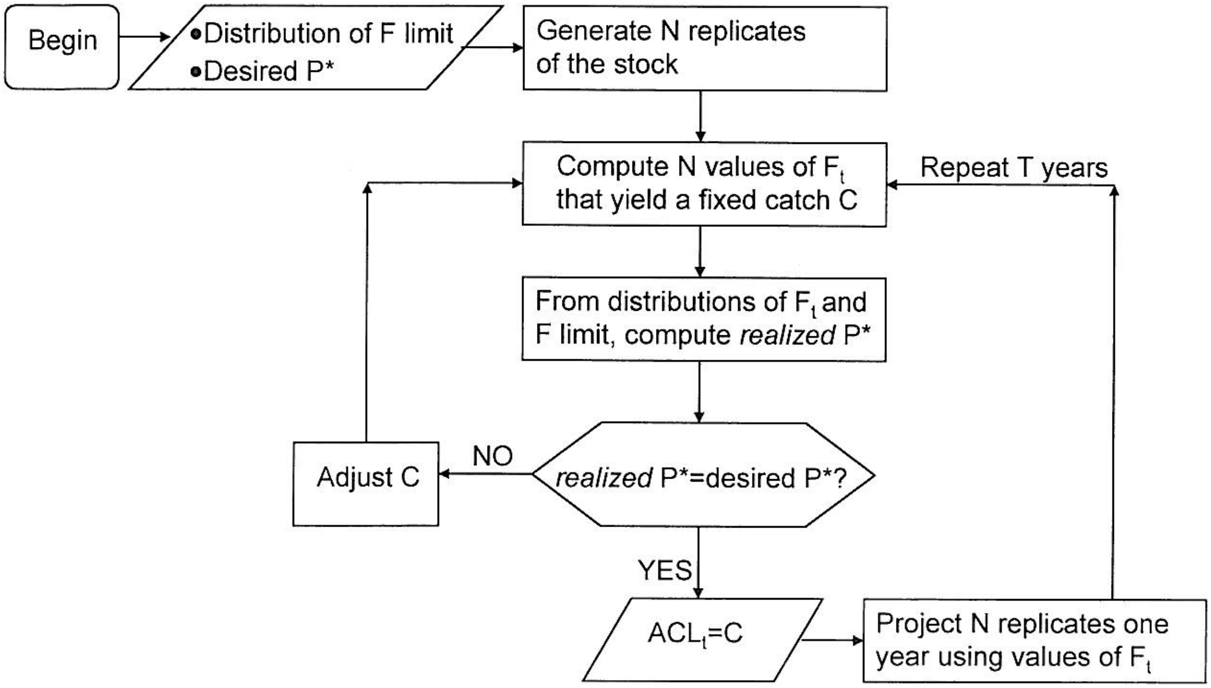


Figure 3. Probability density of F_{MSY}, estimated from the SEDAR 10 assessment and used as input for PASCL.

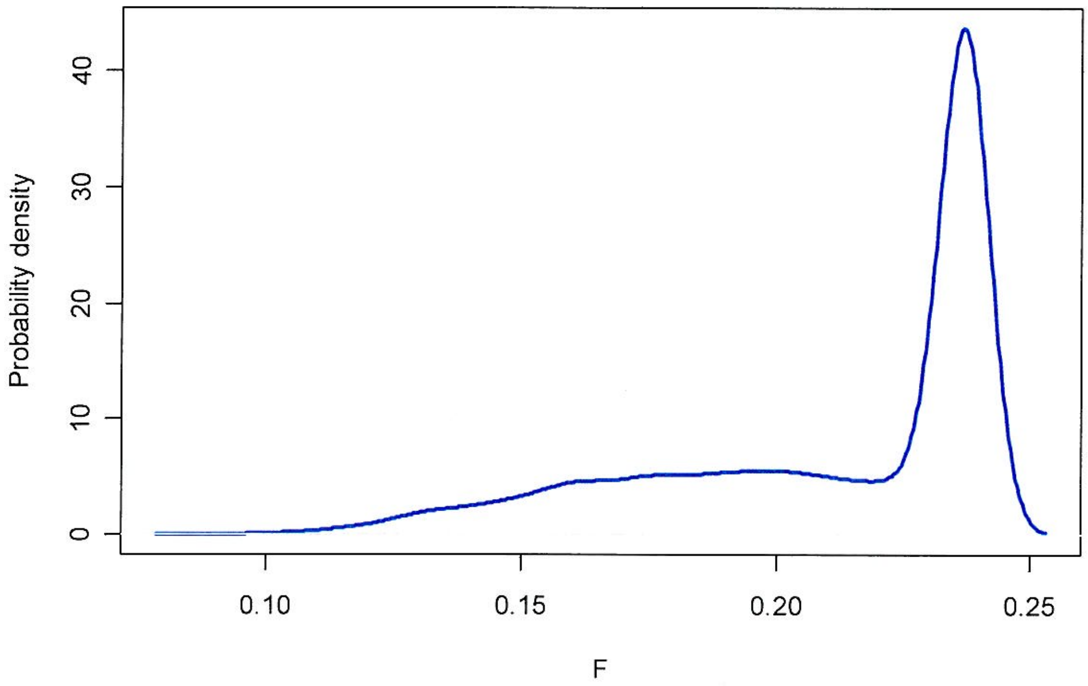
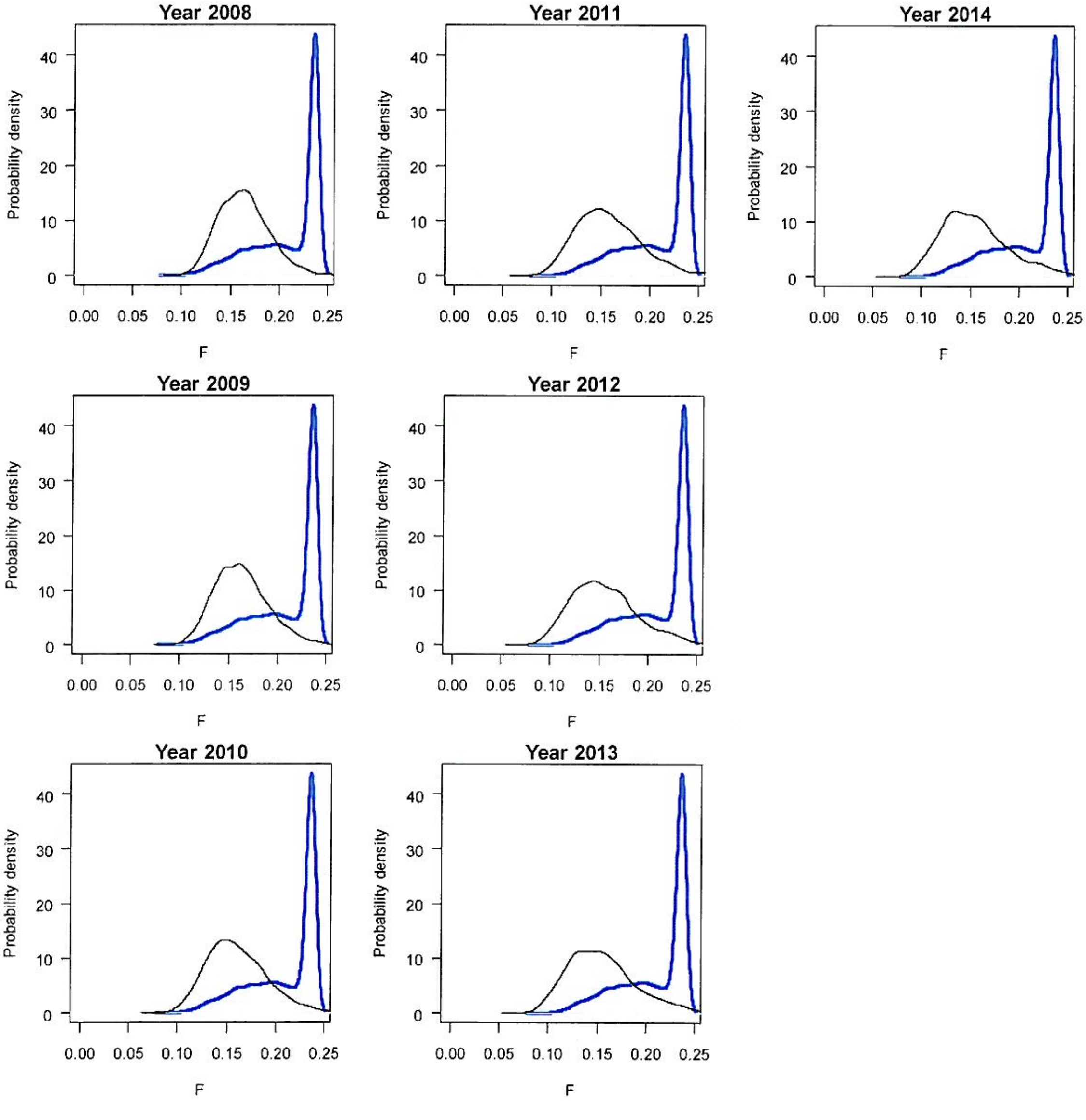


Figure 4. Example distributions: Probability density of F_{MSY} (thick, blue line) and of F_t (thin, black line) that achieve $P^*=0.15$. For lower P^* (less risk), the probability densities of F_t would shift to the left; for higher P^* (more risk), to the right.


Year 2008

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