Proposed Harvest Control Rules for the U.S. Caribbean

SEFSC Staff
CFMC Council Meeting
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What definitions should I know?

- **Overfishing:** The annual rate of catch is too high.

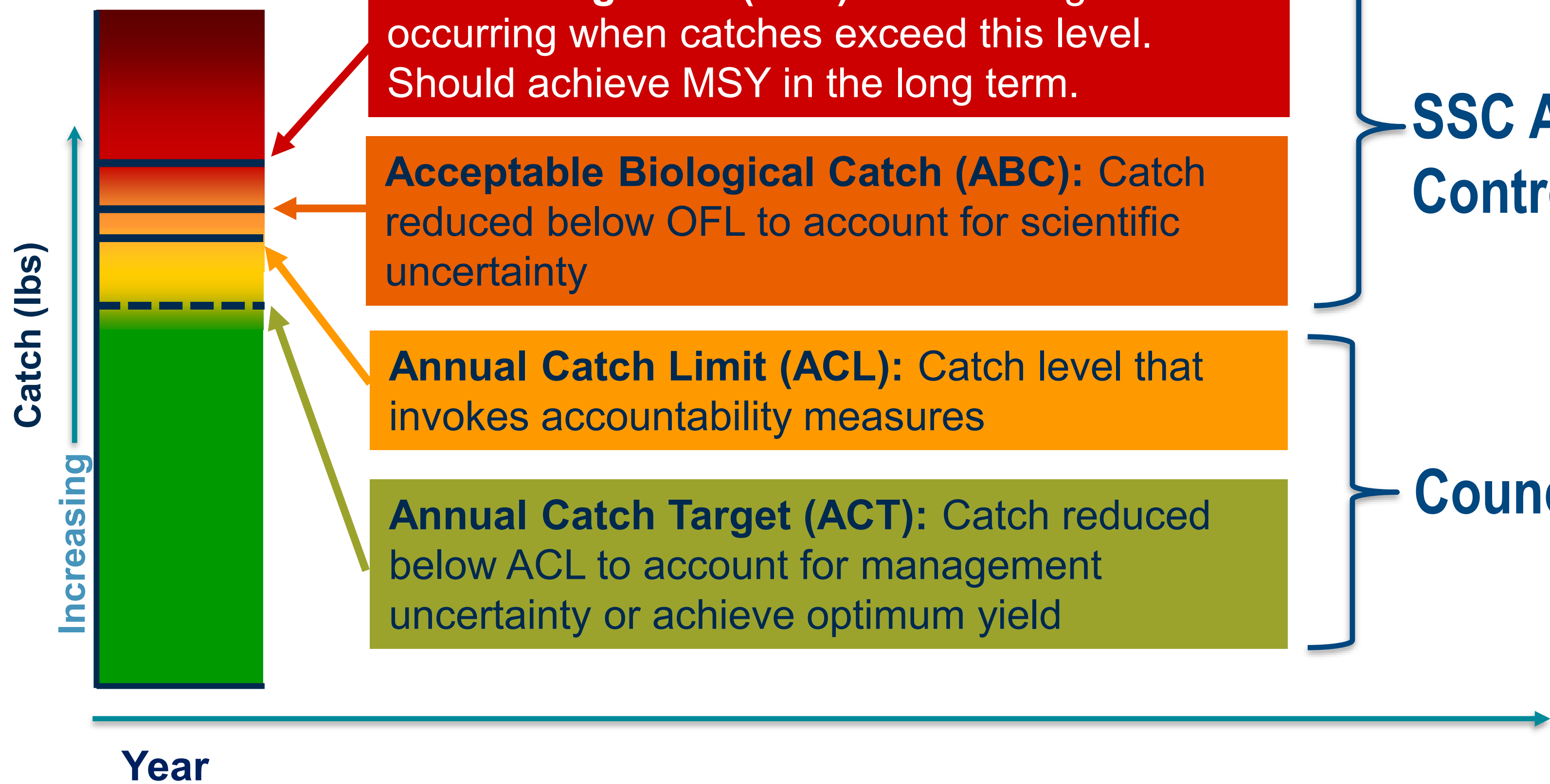
- **Maximum sustainable yield:** The largest, long-term average catch that can be taken under existing conditions.

- **Scientific uncertainty:** Uncertainty in the information about a stock and its maximum sustainable yield reference points. Sources of scientific uncertainty could include stock assessment results, time lags in assessment updates, projections, potential ecosystem and environmental effects, or other factors.

- **Management uncertainty:** Uncertainty in the ability of managers to constrain catch so that the annual catch limit is not exceeded, as well as uncertainty in quantifying the true catch amounts (i.e., estimation errors). Sources could include late catch reporting, misreporting, underreporting, or other factors.

Sorting through the acronyms

$$OFL \geq ABC \geq ABC \geq ACT$$



Overfishing Limit (OFL): Overfishing is occurring when catches exceed this level. Should achieve MSY in the long term.

Acceptable Biological Catch (ABC): Catch reduced below OFL to account for scientific uncertainty

→ SSC ABC Control Rule

Annual Catch Limit (ACL): Catch level that invokes accountability measures

Annual Catch Target (ACT): Catch reduced below ACL to account for management uncertainty or achieve optimum yield

→ Council

Calculating the Overfishing Limit (OFL)

- Over the long term, fishing at the OFL will achieve maximum sustainable yield. The OFL is also an estimate of the catch level above which overfishing will occur.
- The OFL is estimated using a stock assessment.
- Tiers 1-3 of the CFMC ABC Control Rule require stock assessment results to compute OFL.
- The recent Spiny Lobster assessment is a Tier 3 assessment that produced an estimate of OFL.
- ***The SSC requires input from the Council regarding the acceptable risk of overfishing (P*) in order to develop an estimate of ABC***

Tier 3 – Data Limited Stock Assessment

- Condition for use: Relatively ***data-limited*** or out-of-date assessments.
- Status Determination Criteria (SDCs)
  - Maximum Fishing Mortality Threshold (MFMT)
    - Level of fishing mortality (F) above which overfishing is occurring (typically = F_{MSY} or proxy)
  - Minimum Stock Size Threshold (MSST)
    - the stock size below which the stock or stock complex is considered to be overfished (e.g. 75% of Spawning Biomass at MFMT)
  - Maximum Sustainable Yield (MSY)
    - is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing conditions

Tier 3 – Data Limited Stock Assessment

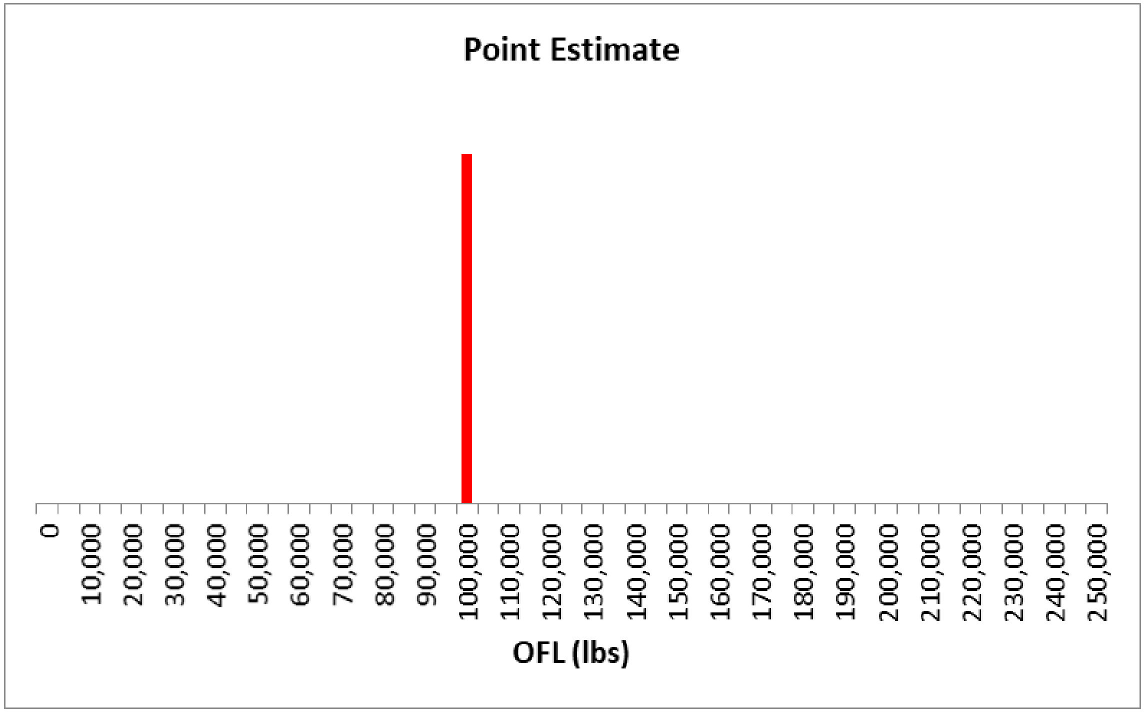
- OFL = the annual catch when fishing at MFMT (typically = F_{MSY} or proxy)
- ABC = the acceptable biological catch, as reduced from OFL by scientific uncertainty and reflecting the acceptable probability of overfishing.
  - Scientific uncertainty is quantified by the SSC taking into account the species life history and ecological function, the perceived level of depletion, and vulnerability of the stock to collapse.
  - Acceptable probability of overfishing determined by Council. Cannot exceed 50%, and should be lower than that.

How does it work?

- Step 1: Estimate OFL using a stock assessment.
- Stock assessments use information about fisheries (e.g. catch, catch per unit effort, length or age comp) and fish (e.g. growth, mortality, reproduction) to estimate trends in fishing mortality and population size as well as current stock status (e.g. overfished, overfishing) and status determination criteria (e.g. MSY, MFMT, MSST).

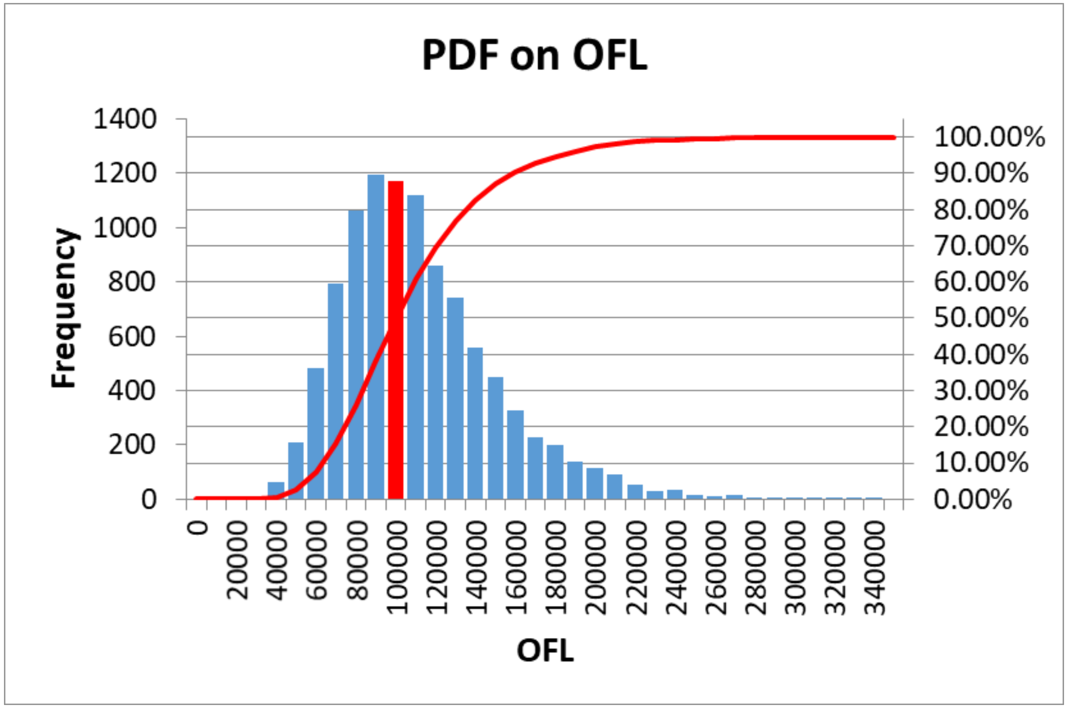
Calculating OFL

- Stock assessment produce a point estimate of OFL. In this case 100,000 lbs.



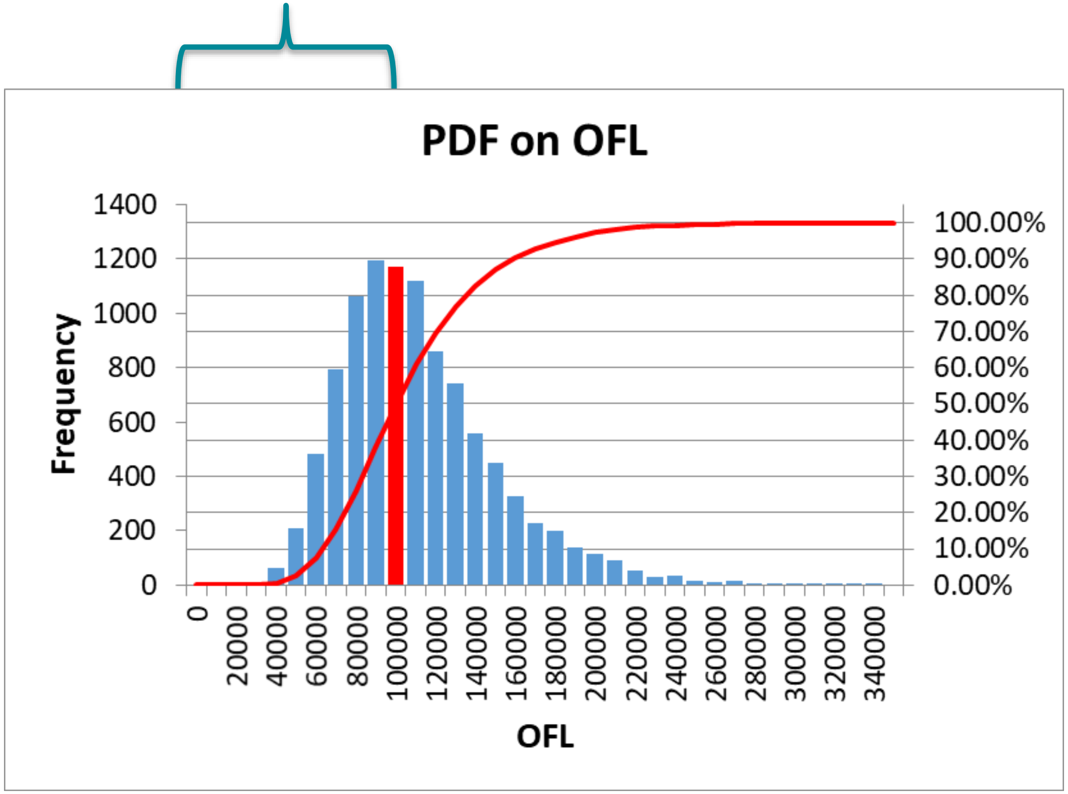
Calculating OFL

- Variance in data inputs and model parameters can be used to produce a range of OFL estimates which is generally referred to as a PDF (probability density function) on OFL. The point estimate is typically the median of the distribution.



Calculating OFL

If the “true” OFL is less than the point estimate (100,000 lbs) this level of catch will cause overfishing. By definition, the risk of overfishing at OFL is 50%.



Calculating ABC

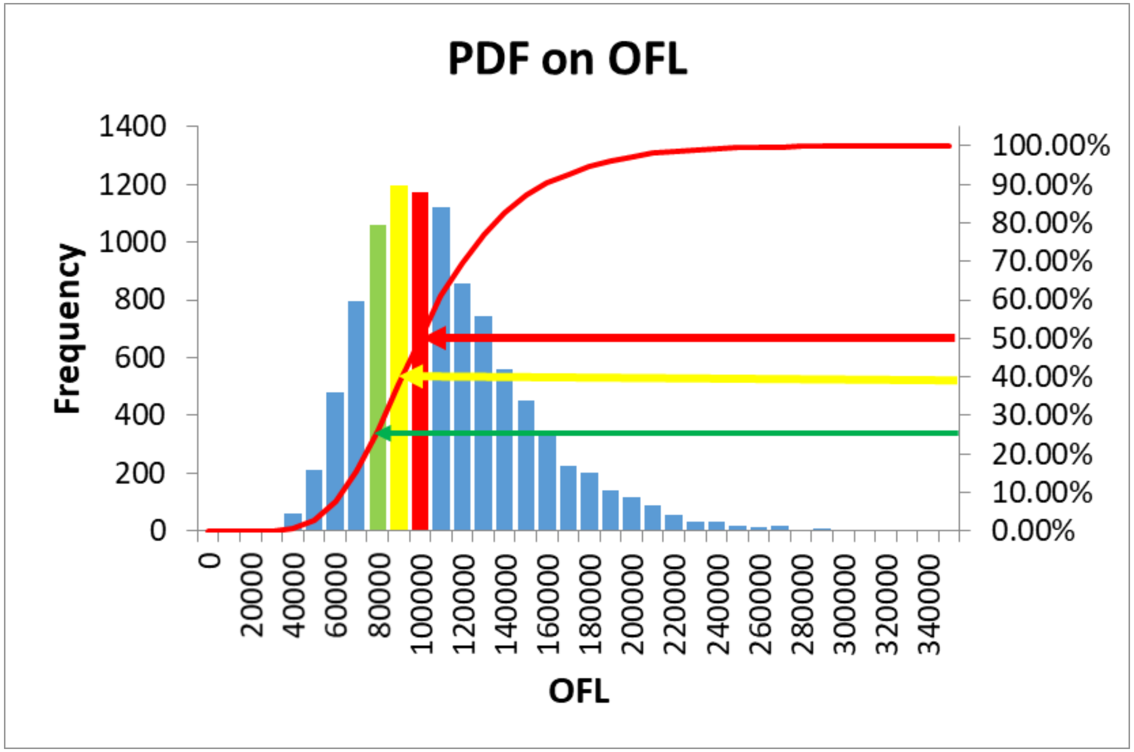
- ABC = the acceptable biological catch, ***as reduced from OFL*** by scientific uncertainty and reflecting the acceptable probability of overfishing (***P****).
- Two variables will determine the magnitude of the reduction from OFL, sigma-min (σmin) and P*
- First, let's look at the effect of P*

Calculating ABC

- The highest legal P* is 0.5 which has a 50% probability of overfishing (OFL = ABC).
- One should only consider a P* near 0.5 for "***data-rich***" assessments, and when ***scientific uncertainty is negligible***.
- Most Council have chosen to use P* values of 0.3 – 0.4 (30% to 40% probability of overfishing) to avoid triggering overfishing/overfished determinations.
- An overfishing determination requires a Council to take action to end overfishing immediately. An overfished determination requires the implementation of a rebuilding plan. In either case significant reductions in catch may be required.

Calculating ABC: Effect of P*

- Using a lower P* reduces the allowable catch in a fishery, but retains a higher stock size and reduces the risk of overfishing.



at σ_{min} = 0.36***

OFL = 50th percentile = 100,000 lbs

Pstar	ABC	% of OFL	%Red
0.5	100000	100%	0%
0.45	95576.99	96%	4%
0.4	91283.06	91%	9%
0.35	87047.58	87%	13%
0.3	82796.52	83%	17%
0.25	78441.56	78%	22%

Calculating ABC: % Red depends on σmin and P*

Ralston et al., 2011

Abstract—Quantifying scientific uncertainty when setting total allowable catch limits for fish stocks is a major challenge, but it is a requirement in the United States since changes to national fisheries legislation. Multiple sources of error are readily identifiable, including estimation error, model specification error, forecast error, and errors associated with the definition and estimation of reference points. Our focus here, however, is to quantify the influence of estimation error and model specification error on assessment outcomes. These are fundamental sources of uncertainty in developing scientific advice concerning appropriate catch levels and although a study of these two factors may not be inclusive, it is feasible with available information. For data-rich stock assessments conducted on the U.S. west coast we report approximate coefficients of variation in terminal biomass estimates from assessments based on inversion of the assessment of the model's Hessian matrix (i.e., the asymptotic standard error). To summarize variation "among" stock assessments, as a proxy for model specification error, we characterize variation among multiple historical assessments of the same stock. Results indicate that for 17 groundfish and coastal pelagic species, the mean coefficient of variation of terminal biomass is 18%. In contrast, the coefficient of variation ascribable to model specification error (i.e., pooled among-assessment variation) is 37%. We show that if a precautionary probability of overfishing equal to 0.40 is adopted by managers, and only model specification error is considered, a 9% reduction in the overfishing catch level is indicated.

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A meta-analytic approach to quantifying scientific uncertainty in stock assessments

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It has long been recognized that precautionary measures in fisheries management should be related to the amount of uncertainty in the science that is used to evaluate stock status (Caddy and McGarvey, 1996; FAO, 1996). However, few fisheries jurisdictions have adopted precautionary harvest control rules that are designed to reduce "risk-neutral" point estimates of catch based on the amount of uncertainty in the estimates, although at least two examples of this type of precautionary approach exist in the management of marine mammal populations. The International Whaling Commission has adopted a management procedure for baleen whales where, for example, a posterior distribution for the output of a harvest control rule is computed, and the catch limit is set close to the 40th percentile of the distribution (IWC, 1999; Punt and Donovan, 2007). Likewise, with the potential biological removals method (Wade, 1998), the level of marine mammal take at which management action must occur is based on the 20th percentile of the most recent estimate of abundance.

The reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) in 2006 changed the requirements for how management actions are developed for U.S. fisheries. The eight Regional Fishery Management Councils are now required to set annual catch limits (ACLs) for all managed stocks that are "in the fishery." National Standard Guidelines have now been developed to assist in the implementation of the reauthorized act (Federal Register, 2009), which defines two sources of uncertainty that must be considered when establishing ACLs: 1) scientific uncertainty, including error pertaining to both the data and to parameter estimation; and 2) management uncertainty, which represents uncertainty in the efficacy of management practices that are designed to ensure that harvest limits are not exceeded. The focus of this study is on the first of these two sources of uncertainty.

Defining "scientific uncertainty" is not trivial. It is therefore not surprising that a variety of approaches have been taken to quantifying un-

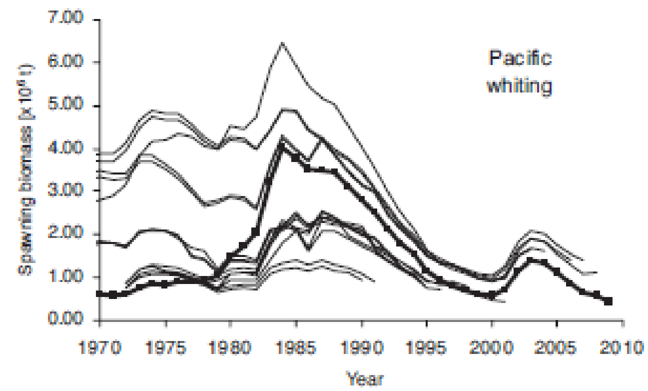


Figure 1
Biomass time series for Pacific whiting (*Merluccius productus*) based on 15 historical stock assessments conducted for the Pacific Fishery Management Council. The bold line with square symbols represents the most recent stock assessment used in the meta-analysis; the other lines represent time series of abundance developed from earlier assessments.

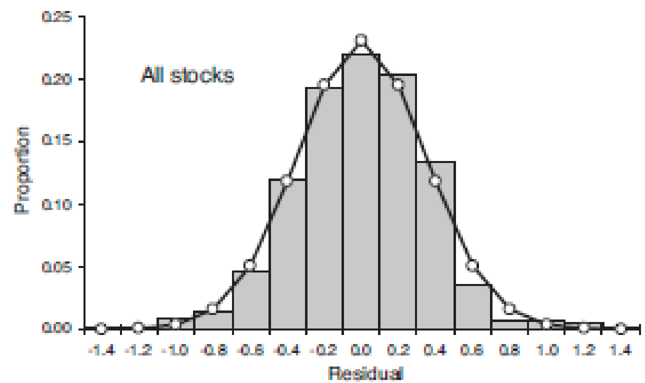
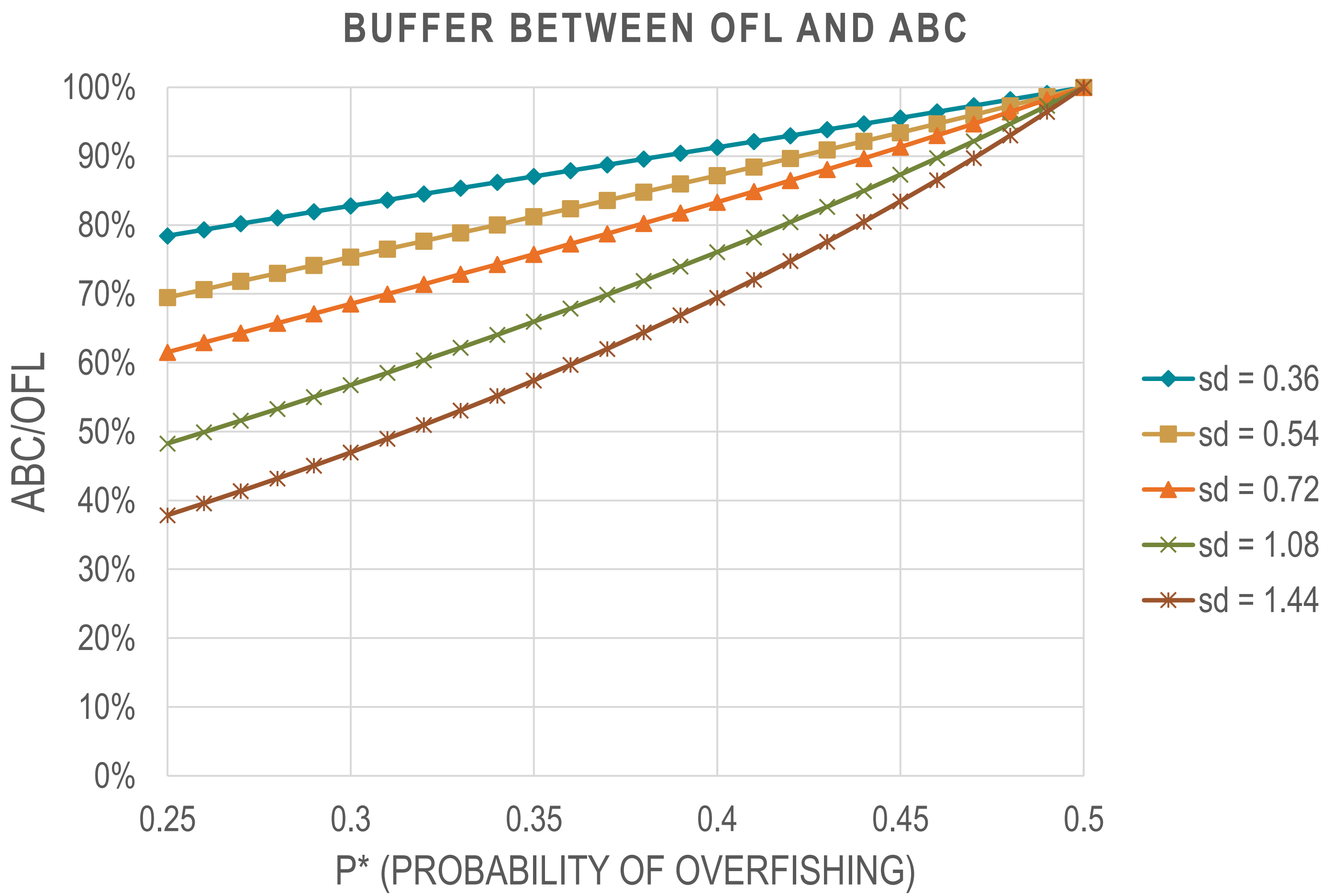


Figure 6
Aggregate distribution of log-deviations pooled over all 17 stocks with the fit of a normal distribution shown as the line with symbols (σ =0.36).

Calculating ABC: % Red depends on σmin and P*



Spiny Lobster Example

- This table shows the OFLs estimated by the model.
- Let's look at the 2020 OFL in STT
- Let's assume Tier 3 ($\sigma = 2^* \sigma min$), and $\sigma min = 0.5$.

PRELIMINARY OFL (lbs)			
YEAR	STT	STX	PR
2020	160,433	155,412	469,402
2021	148,088	141,965	452,682
2022	142,134	136,512	445,728

P*	***PRELIMINARY*** ABC	% of OFL	%Red
0.50	160,433	100%	0%
0.45	141,488	88%	12%
0.40	***124,528***	***78%***	***22%***
0.35	109,132	68%	32%
0.30	94,962	59%	41%
0.25	81,727	51%	49%

Spiny Lobster Example

- Now let's do the whole table
- Let's assume Tier 3 (σ = 2* σmin), and σmin = 0.5.
- Let's assume P* = 0.4

PRELIMINARY OFL (lbs)			
YEAR	STT	STX	PR
2020	160,433	155,412	469,402
2021	148,088	141,965	452,682
2022	142,134	136,512	445,728

PRELIMINARY ABC (lbs)			
YEAR	STT	STX	PR
2020	***124,528***	120,631	364,350
2021	114,946	110,193	351,372
2022	110,324	105,961	345,974

ACL 2012	**104,307**	**107, 307**	**327,920**
ABC IBFMPs	220,221	207,925	554,981
ACL IBFMPs	**209,210**	**197,528**	**527,232**
SEDAR 57 MSY	134,000	128,000	433,000

NOAA FISHERIES