SEDAR 46 Stock Assessment Review Workshop

Part 1: Introduction

Sustainable Fisheries Division
Southeast Fisheries Science Center,
Miami, Florida

February 23, 2016

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Outline

- SEDAR 46 Terms of Reference
- Management in the US Caribbean
- Assessment history in the US Caribbean
- Species-island unit selection
- SEDAR 46 stock evaluation approach:
  1. DLMtool (Carruthers et al. 2014)
  2. Mean Length Estimator

SEDAR 46 Terms of Reference

1. Review results of the SEDAR 46 ***Data Triage*** (SEFSC 2015), documenting available data for US Caribbean species managed by the Caribbean Fishery Management Council.

2. Discuss and recommend species with sufficient data for evaluation using data-limited assessment models.

3. Apply various data-limited modeling techniques, as appropriate, to the recommended species in order to provide management advice.

4. Prepare Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines.

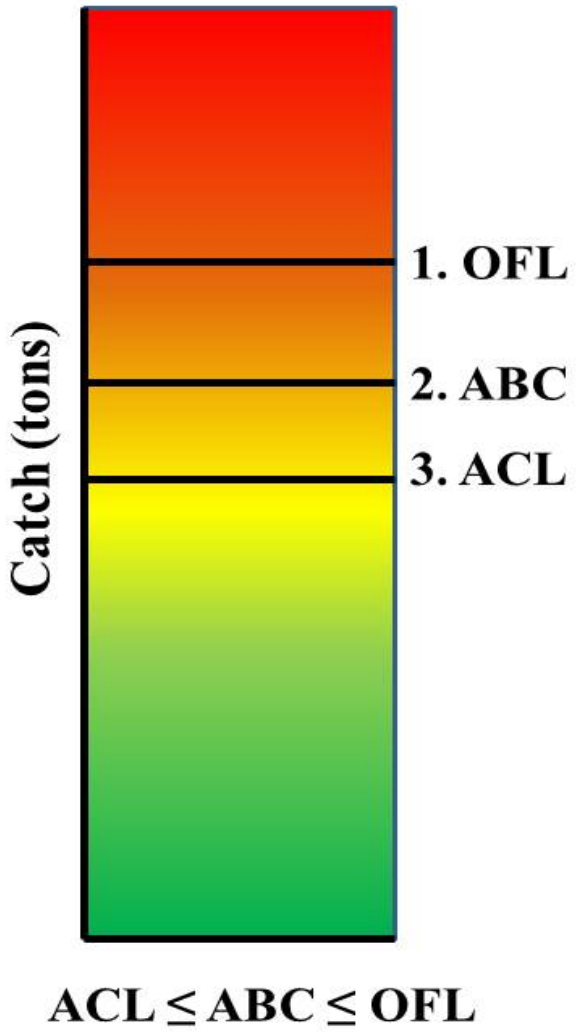
SEDAR 46 Terms of Reference (continued)

- TOR1: **Review *Data Triage* results**
  - *Addressed in Presentation 1: Data Review*

- TOR2: ***Recommend species*** with sufficient data for evaluation using data-limited techniques
  - *Addressed in Presentation 1: Data Review*

- TORs 3-4:
  - *Addressed in Presentation 2: **DLMtool Stock Evaluation and** Presentation **3: Mean Length Estimator Evaluation***

US fisheries management advice:



1. Determine Overfishing Limit (OFL)
Who: Federal (NMFS) or State
How:
- Data-moderate: stock assessment (e.g., MSY estimated using statistical catch-at-age model)
- Data-limited: MSY proxy (e.g., reproductive potential)
- Data-poor: ?

2. Determine Acceptable Biological Catch (ABC)
Who: Scientific and Statistical Committee (SSC)
How:
- Harvest control rule – pre-defined control rule that is intended to account for scientific uncertainty in the OFL estimate
  - e.g., ABC = 0.75 x OFL

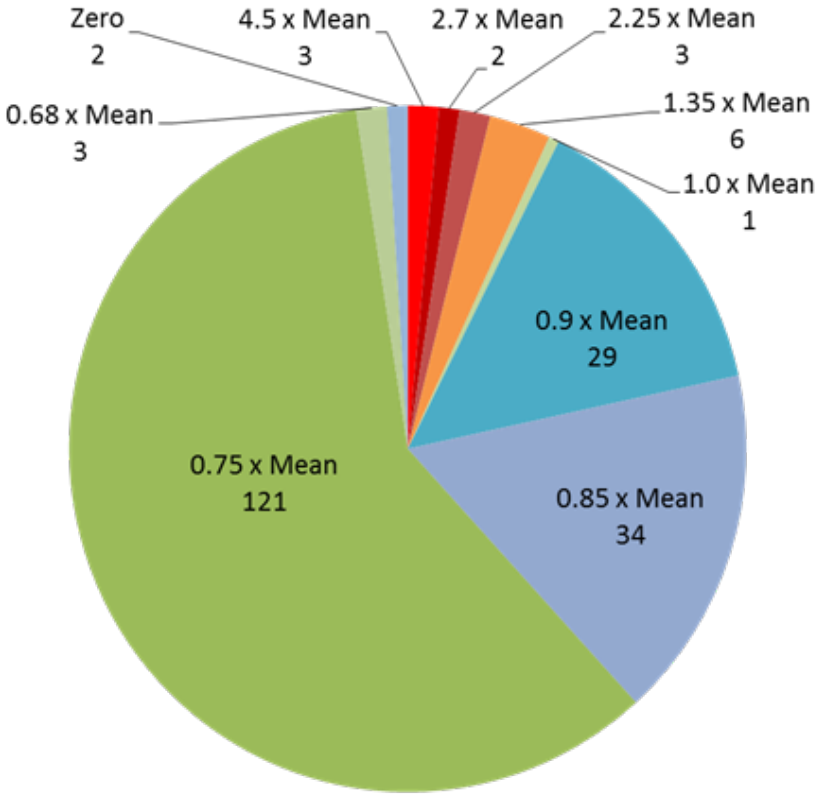
3. Determine Annual Catch Limit (ACL)
Who: Fishery Management Council
How:
- Based upon scientific recommendations which account for various ecological, social and economic factors

Figure modified from National Standard Guidelines 1

Setting catch limits in the US Caribbean

- OFLs/ABCs in the US Caribbean set using data-poor methods (Newman et al. 2015)

- Procedure reliant on recent landings history and catch scalars
  - Often perform poorly in simulation analyses
    - Carruthers et al. 2014
    - ICES 2012
    - Geromont and Butterworth 2014



Catch setting methods in the US Caribbean

SEDAR assessment history in the US Caribbean

Assessment	Year	Species		Method
SEDAR 35	2014	Red hind	*Epinephelus guttatus*	Mean length estimator, Per recruit analyses
SEDAR 30	2013	Queen triggerfish	*Balistes vetula*	Beverton-Holt length-based mortality estimator
SEDAR 30	2013	Blue tang	*Acanthurus coeruleus*	Beverton-Holt length-based mortality estimator
SEDAR 26	2011	Redtail parrotfish	*Sparisoma chrysopterum*	Beverton-Holt length-based mortality estimator
SEDAR 26	2011	Queen snapper	*Etelis oculatus*	Beverton-Holt length-based mortality estimator
SEDAR 26	2011	Silk snapper	*Lutjanus vivanus*	Beverton-Holt length-based mortality estimator
SEDAR 14	2007	Yellowfin grouper	*Mycteroperca venenosa*	None
SEDAR 14	2007	Mutton snapper	*Lutjanus analis*	None
SEDAR 14	2007	Queen conch	*Strombus gigas*	None
SEDAR 08	2005	Yellowtail snapper	*Ocyurus chrysurus*	Catch-free, ASPIC, yield-per-recruit
SEDAR 08	2005	Caribbean spiny lobster	*Palinurus argus*	ASPIC, SSASPM, Length-based methods

SEDAR assessment history in the US Caribbean

Assessment	Year	Species	Method
SEDAR 35	2014 Red hind	*Epinephelus guttatus*	Mean length estimator, Per recruit analyses

- Prior to SEDAR 35, no catch limits provided
- Red hind examination was the first to link YPR to an OFL calculation
- Was not used for management advice in the end due to concerns over data in different island platforms

Photos from NOAA Photo Library (http://www.photolib.noaa.gov/).

Species-island unit selection

PR hogfish

STT queen triggerfish

STX spiny lobster

PR yellowtail snapper

STT spiny lobster

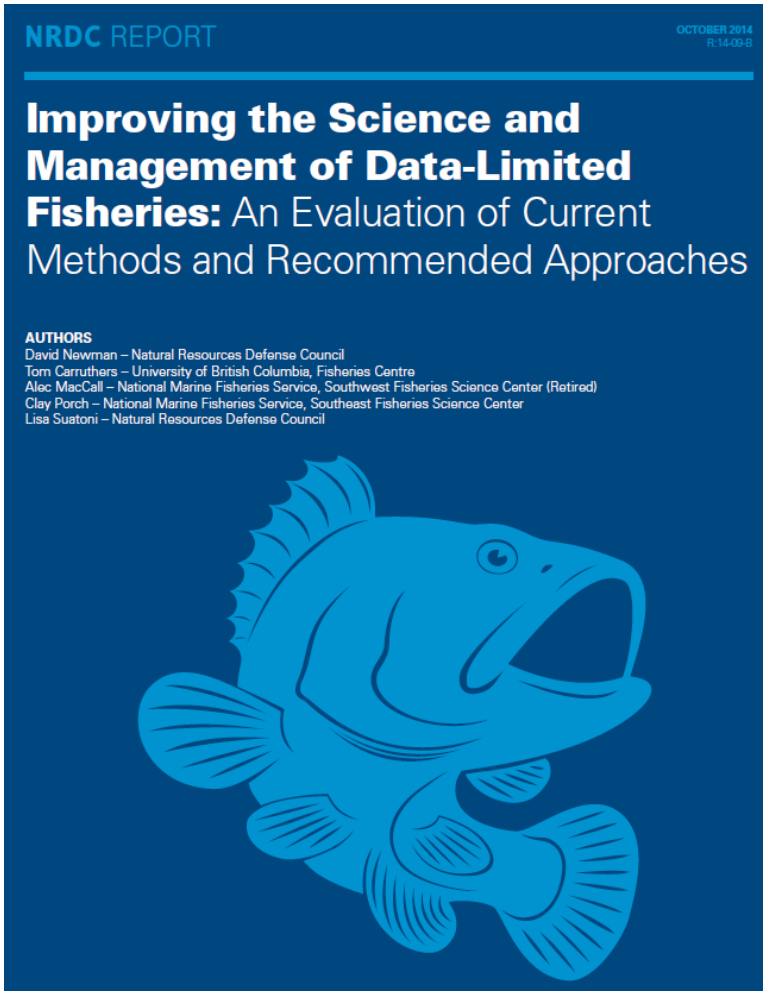
STX stoplight parrotfish

SEDAR 46 species assessment history

Species unit assessed	Assessment method	Assessment reference
Puerto Rico hogfish dive	• NA	None
Puerto Rico yellowtail snapper handline	• CPUE trends, examination of changes in length frequency	SEDAR (2005b)
	• Length frequency analyses	Appeldoorn et al. (1992)
St. Thomas queen triggerfish trap	• Length frequency analysis from the pot and trap fishery (Puerto Rico), Gedamke - Hoenig mean length estimator	SEDAR (2013)
St. Thomas spiny lobster trap	• Stock production model, CPUE examinations, yield per recruit	SEDAR (2005a)
	• CPUE and landings trends	Matos-Caraballo (1999)
	• Landings and length frequency	Bolden (2001)
	• CPUE	Bohnsack et al. (1991)
St. Croix spiny lobster dive	• Stock production model, CPUE examinations, yield per recruit	SEDAR (2005a)
	• CPUE and landings trends	Matos-Caraballo (1999)
	• Landings and length frequency	Bolden (2001)
	• Production model	Mateo and Tobias (2002)
	• CPUE	Bohnsack et al. (1991)
St. Croix stoplight parrotfish trap	• NA	None

Approach #1: Data-Limited Methods Toolkit (DLMtool)

- Collaboration between the University of British Columbia and the National Resources Defense Council
- R package consists of a set of peer reviewed data-limited assessment models, control rules and management procedures (**MPs**)
- Widely available



Subset of management procedures (MPs) in DLMtool

Method / Management Procedure	Description	Reference	Data Inputs																									
			Mort	L50	vbt0	vbK	vbLinf	wla	wlb	steep	MaxAge	Cat	AvC	LFC	LFS	CAA	CAL	FMSY_M	BMSY_B0	Cref	Bref	Iref	Ind	Rec	Dt	Dep	Abun	Mprec
Catch-based																												
CC4	Constant Catch linked to average catches (TAC = 0.7 x $C_{average}$)	Geromont and Butterworth (2014b); Carruthers et al. (2015)										■																
SPMSY	Surplus Production MSY	Martell and Froese (2012)		■	■	■	■				■	■																
Index-based																												
Islope	CPUE slope (maintain constant CPUE)	Geromont and Butterworth (2014b); Carruthers et al. (2015)										■											■					
Depletion-based																												
DCAC	Depletion-Corrected Average Catch (DCAC)	MacCall (2009); Carruthers et al. (2014)	■										■					■	■						■			
Abundance-based																												
Fratio	FMSY to M ratio	Gulland (1971); Walters and Martell (2002); Martell and Froese (2012); Carruthers et al. (2014)	■															■									■	
Data-moderate																												
DD	Delay-Difference stock assessment model	C. Walters; Carruthers et al. (2014)	■	■	■	■	■	■	■		■	■											■					
Length-based																												
LstepCC1	Mean length (Mean length relative to historical levels used to alter TAC; TAC = $C^{average}$)	Geromont and Butterworth (2014b); Carruthers et al. (2015)										■					■											

Full list of MPs provided in Table 3.2.1

Advantages of the DLMtool approach

- Applies closed-loop management strategy evaluation (MSE) that allows for testing performance of MPs
- Facilitates sensitivity testing of catches to data inputs
- Products provide quantitative guidance on prioritizing data collection in a cost-effective manner
- Promotes transparency, credibility, and increased buy in from fishery managers and stakeholders
- Integrates feedback control into the decision making process not presently considered in the US Caribbean

Applications of the DLMtool

- Being considered for "***interim***" management advice in some regions for data poor species (2 regions)

  - Mid-Atlantic Fishery Management Council
    - **Black sea bass (Nov 2015) advice used to set catches**
    - Atlantic mackerel (April 2015)- exploratory

  - New England Fishery Management Council
    - Catch Advice Methods for the Northeast Multispecies Fishery

SEDAR 46 Stock evaluation approach using DLMtool

DLMtool Step 1: Management Strategy Evaluation (MSE)

- Specified species-island unit operating models (OMs) with 3 subclasses:
  - Stock: representative of the stock dynamics
  - Fleet: representative of fishery characteristics
  - Observation: parameters control data quality in simulation

- Parameterized 1) **"base"** OM and 2) "**alternatives**" OMs based on varying inputs to address sensitivities

- OMs assumed to capture reasonable ranges of life history and fishery dynamics for each species-island unit

MSE inputs by OM component

Stock: life history and depletion

"Name" "maxage" "R0" "M" "Msd" "Mgrad" "h"
"SRrel" "Linf" "K" "t0" "Ksd" "Kgrad" "Linfsd"
"Linfgrad" "recgrad" "a" "b" "D" "Perr" "Size_area_1"
"Frac_area_1" "Prob_staying" "AC" "L50" "L50_95" "Source"

Fleet: fishery selectivity and index of fishing effort

"Name" "nyears" "Spat_targ" "Fsd" "Fgrad" "qinc" "qcv" "L5"
"LFS" "Vmaxlen"

Observation: quality of data inputs

"Name" "LenMcv" "Cobs" "Cbiascv" "CAA_nsamp" "CAA_ESS"
"CAL_nsamp" "CAL_ESS" "CALcv" "Iobs" "Mcv" "Kcv" "t0cv"
"Linfcv" "LFCcv" "LFScv" "B0cv" "FMSYcv" "FMSY_Mcv"
"BMSY_B0cv" "rcv" "Dbiascv" "Dcv" "Btbias" "Btcv" "Fcurbiascv"
"Fcurcv" "hcv" "Icv" "maxagecv" "Reccv" "Irefcv" "Crefcv"
"Brefcv" "beta"

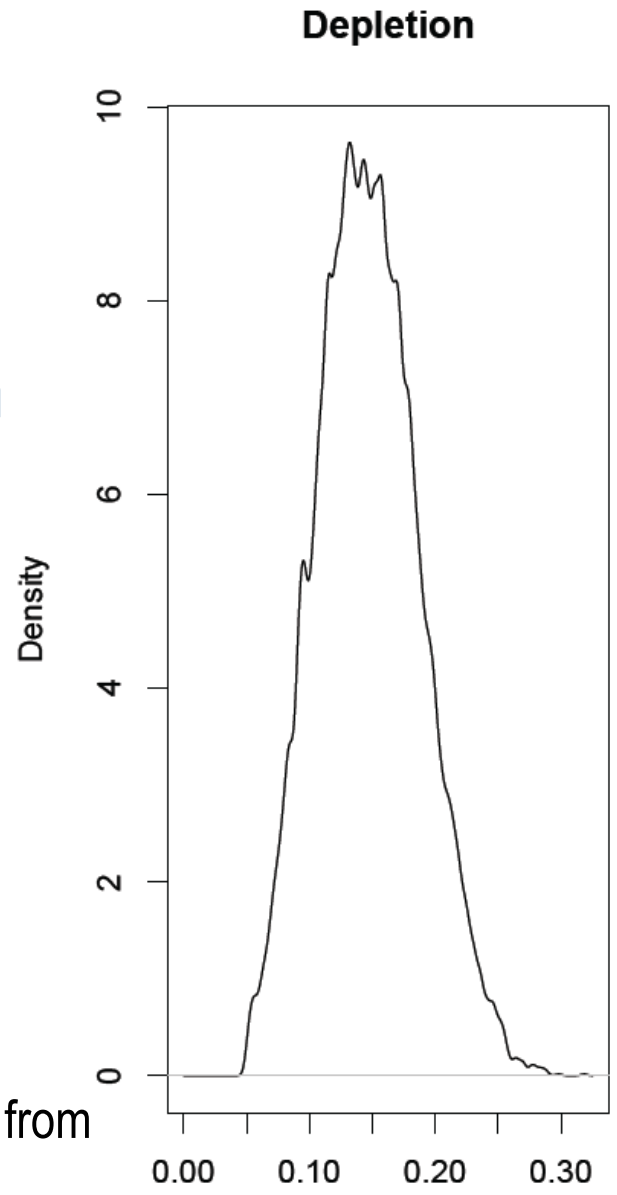
Stock: Life History

Input	Definition	DLMtool		Units
		MSE stock input range (lower bound, upper bound)	Real world input (point estimate & CV)	
Von Bertalanffy Growth	Asymptotic length	Linf	vbLinf	mm FL
	Brody growth coefficient	K	vbK	year $^{-1}$
	Theoretical age at length 0	t0	vbt0	years
Weight-length	Weight-length scalar	a	wla	dimensionless
	Weight-length power	b	wlb	dimensionless
Maturity	Length at 50% maturity	L50	L50	mm FL
	Length at 95% maturity	L50_L95	L95	mm FL
Maximum age	Maximum age	maxage	MaxAge	years
Natural mortality	Natural mortality	M	Mort	year $^{-1}$
Steepness	Steepness of the spawner-recruitment curve	h	steep	dimensionless

Life History inputs obtained from SEDAR 46 DW/AW data triage and expert opinion

Stock: Depletion

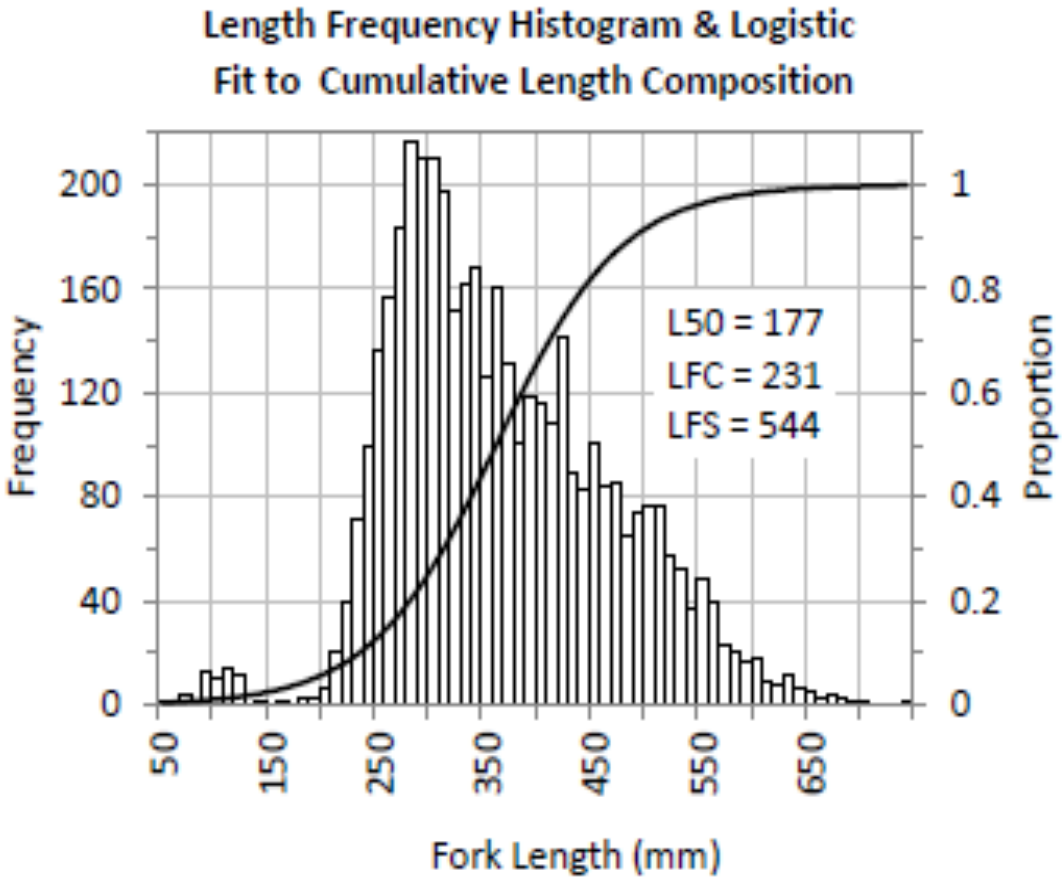
- *Highly uncertain* estimate obtained from ML2D function in DLMtool using:
  - *Mean length observations* obtained from the NOAA Fisheries, Southeast Fisheries Science Center [SEFSC] Trip Interview Program database, TIP samples
  - *OM parameters* (life history, selectivity)



Rough estimate of depletion obtained from SEDAR 46 DW data triage

Fleet: Fleet selectivity & derivation

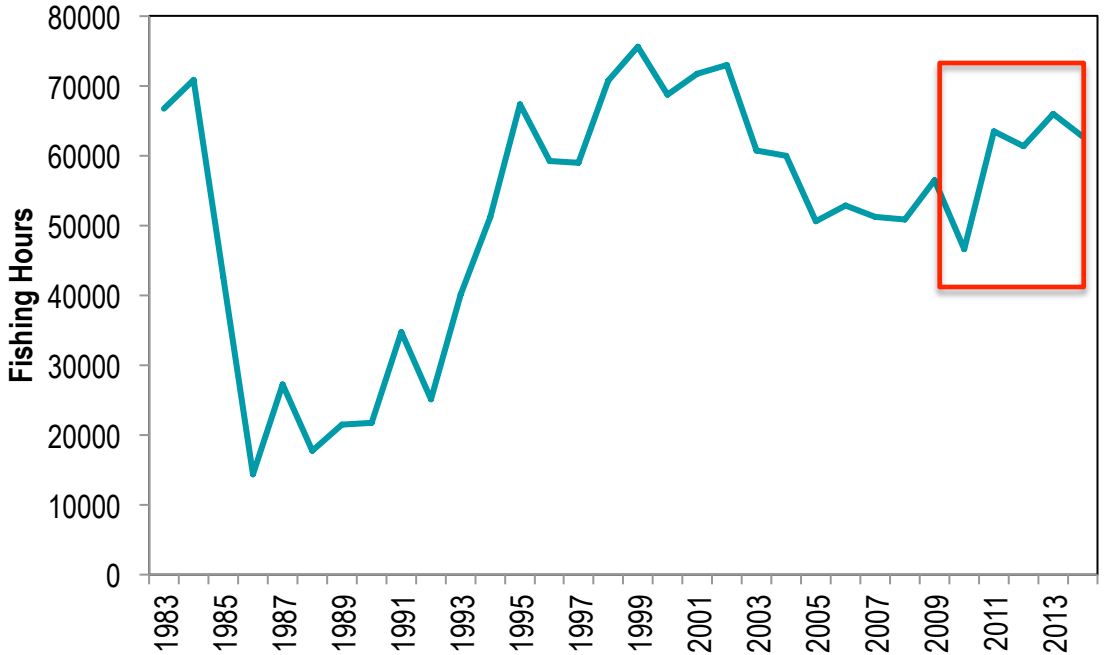
- Derived from *length composition* of representative fishery
  - LFC = length at first capture
  - LFS = length at full selection



Inputs obtained from SEDAR 46 DW data triage

Fleet: Effort

- *Index* of fishing effort
- Derived from most representative fleet
  - Trend in most recent 5 years (red box) sets Fgrad



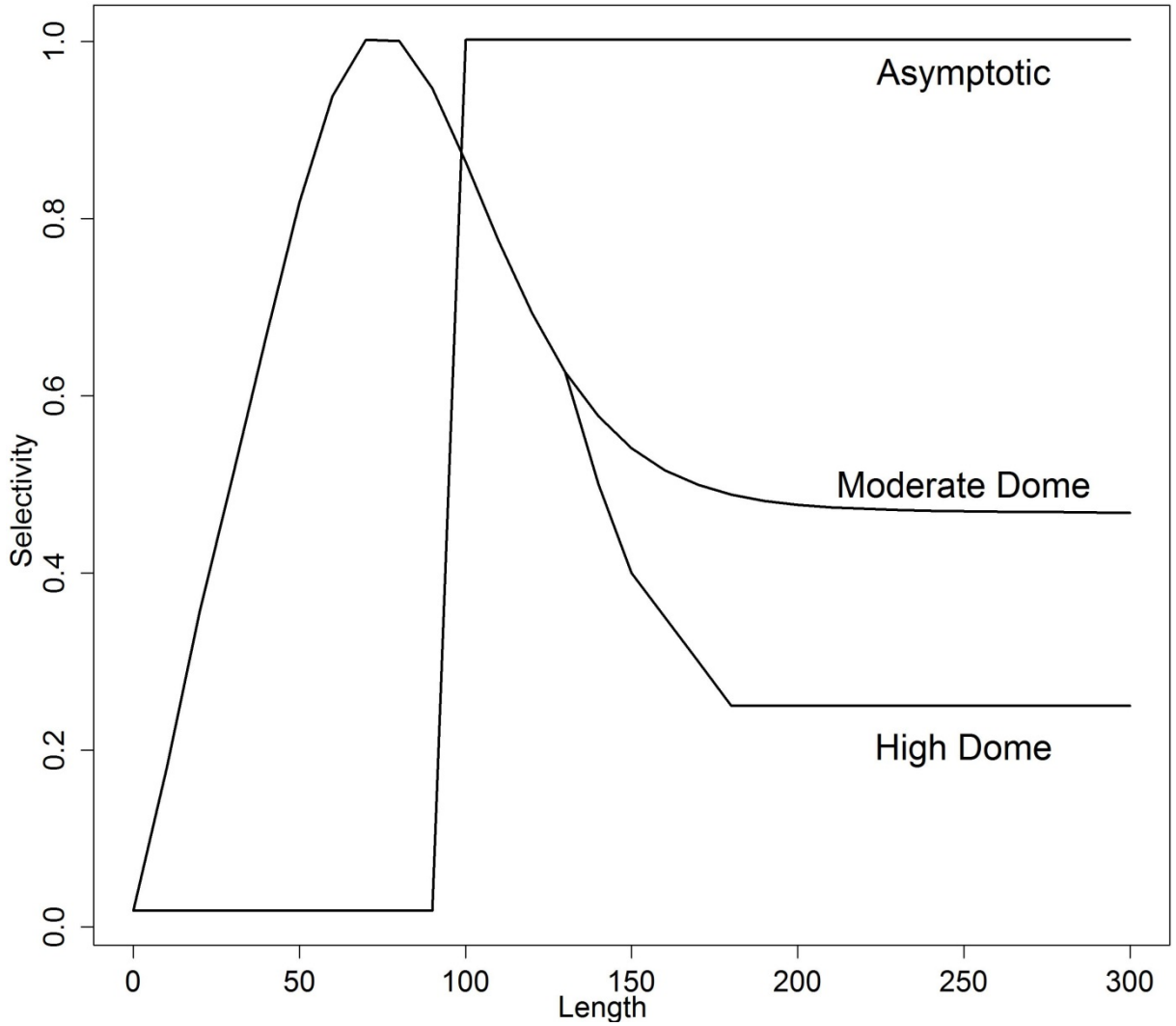
Inputs: SEDAR 46 DW/AW data triage

Trend in Effort	Fgrad
Decreasing	c(-1,0)
Constant	c(-0.5, 0.5)
Increasing	c(0, 1)

Fleet: Fishery characteristics

- Vulnerability of oldest age class
  - controls extent of dome-shaped selectivity

=1	Asymptotic
<1	Dome-shaped



OM sensitivities – Stock subclass

Examined assumptions on life-history parameters due to concerns raised by the Life History Working Group:

- *Difficulty in assigning CVs to parameters*
- *Parameters from outside U.S. Caribbean*

- Base stock: assumed **±15% variability** in M, Linf, and K
- Alternative stock: assumed **±5% variability** in M, Linf, and K

OM sensitivities – Fleet subclass

Examined assumptions on selectivity due to concerns raised and discussed at the SEDAR46 DW/AW Workshop Juan

- **Base fleet subclass**:
  - Asymptotic selex: (Vmaxlen = 1.0)
    - PR hogfish, PR yellowtail snapper, STX stoplight parrotfish
  - High dome-shaped selex: (Vmaxlen range = 0 – 0.5)
    - STT queen triggerfish, STT spiny lobster, STX spiny lobster

- **Alternative fleet subclass**:
  - Moderate dome-shaped selex: (Vmaxlen = 0.2 – 0.5)

OM sensitivities – Observation subclass

Examined assumptions on the quality and bias in data inputs

- **Base observation**: Precise, unbiased data inputs
- **Alternative observation**: Imprecise, biased data inputs
  - Note that observation model parameters are based on assumptions and not analyses

Simulation framework

- DLMtool applied in a simulation framework to aid in identifying applicable management procedures (MPs) meeting specific performance criteria identified by stakeholders (fishers, scientists, managers) at the SEDAR 46 DW/AW workshop
  - Simulations: n=500
  - Repetitions: n=250
  - Projection duration: 40 years
  - Assessment interval: 3 years

MSE performance criteria determined by SEDAR 46 DW/AW Panel and supported by CFMC/SSC

- Explored relative performance among MPs using:
  - Probability of not overfishing (**PNOF**):
    - Restricted results to Pr[NOF] ≥ 50%
  - Probability of the biomass remaining above half BMSY (**B50**):
    - Restricted results to Pr[B50] ≥ 50%
  - Average annual variability in yield to remain within 15% (**AAVY**):
    - Restricted results to Pr[AAVY < 15%] ≥ 50%

MP selection for catch recommendations

Should consider at a minimum:

- Are MP *assumptions* met or violated
- *Tradeoffs* in performance metrics
- *Sensitivity* of catch estimates to input parameters
- *Data quality* used in interpretation of results
  - E.g., are depletion and/or abundance estimates reasonable?
  - E.g., is the index of abundance representative of trends in the resource?

- ***MPs should not be*** selected simply on yield results (i.e., which MP produces highest catch recommendation)

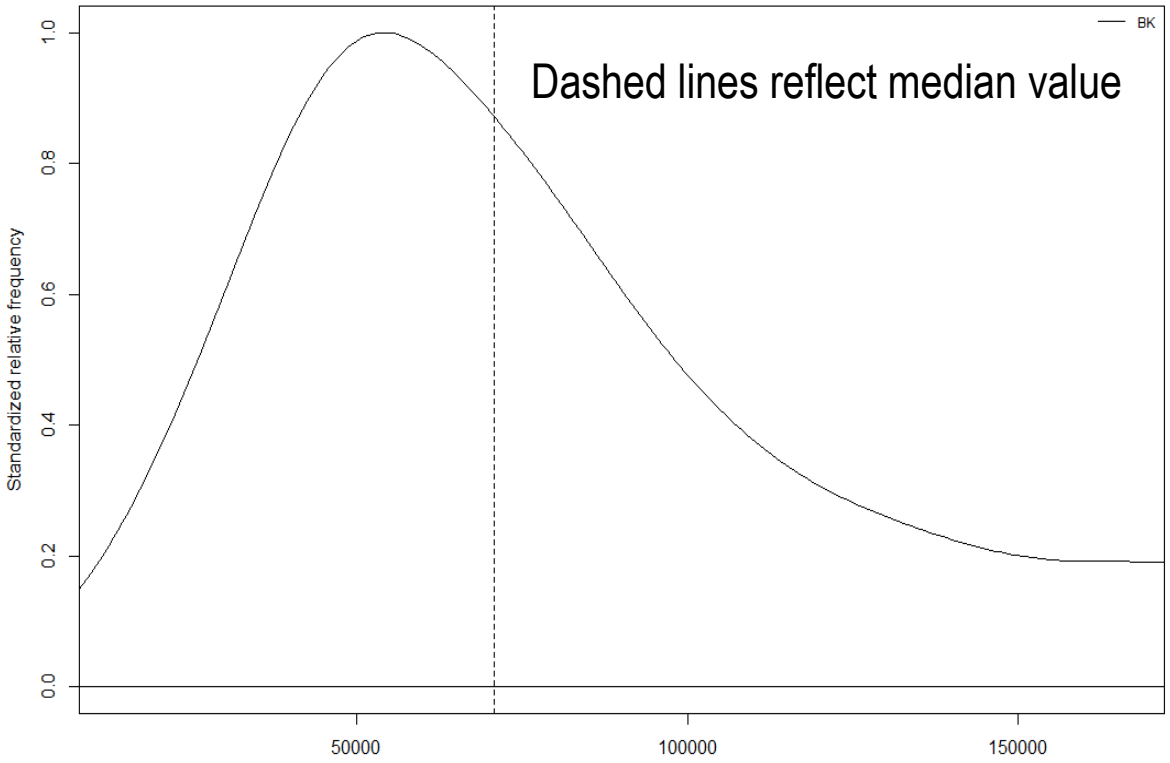
DLMtool Step 2: Calculation of catch recommendations (i.e., TACs)

Definition:

- TAC = overfishing limit (OFL) for most MPs

Sensitivity Important

- Explore sensitivity of TACs to varying input assumptions through sensitivity examinations



Real world data inputs for catch recommendations

- Total removals
- Index of abundance
- Length composition
- Depletion
- Current abundance:

$$Abun = Catch / FMSY / M \times Mort$$

  - Catch = terminal year catch
  - FMSY/M assumed equal to 0.75
  - Mort estimated by SEDAR 46 DW/AW life history group

Review: SEDAR 46 DLMtool Approach (MSE and real world application)

Step 1: MSE

- Specify MSE inputs for OMs
- Specify alternatives OMs
- Specify performance criteria
- Identify feasible MPs
- Run MSE
  - Comparison of MP results
    - Convergence
    - Tradeoffs
    - Sensitivities

Step 2: TAC

- Calculate real world TACs
  - Sensitivities
- Guidance for interpretation of results

Approach #2: Mean Length Estimator

- Non-equilibrium extension of the Beverton-Holt mean length mortality estimator
  - Gedamke and Hoenig (2006)

- More detailed methods and results will be presented by Quang Huynh in Presentation 3

Questions & Comments: DLMtool Methods & Approach

Proceeding to step 2: SEDAR 46 Results