South Atlantic Dolphinfish MSE

3. Inputs

a. Fishery Data

b. Biological Data and Parameters

c. VAST Index



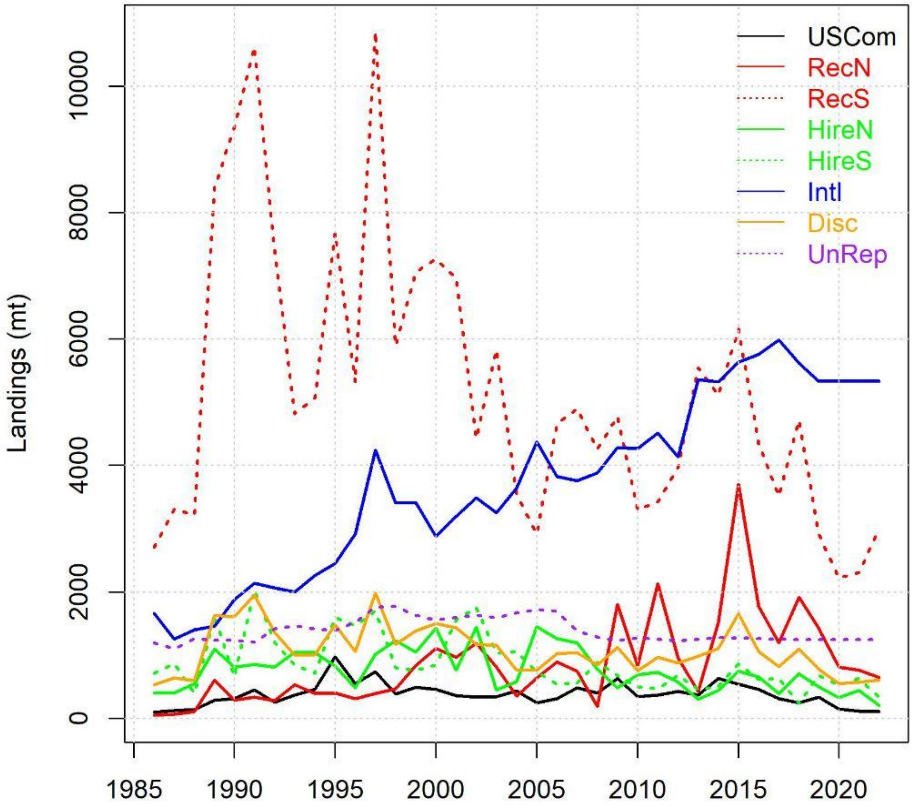
27th July 2026

Tom Carruthers
Cassidy Peterson
Mandy Karnauskas

3a. Fishery Data

Fleet Structure

Code	Fleet	Areas
USCom	USA commercial landings	All
RecN	Recreational North	NNC+VBM
RecS	Recreational South	CAR+FLK, NCFL
HireN	For hire North	NNC+VBM
HireS	For hire South	CAR+FLK, NCFL
Intl	International	CAR+FLK, NCA, NED
Disc	Discard	CAR+FLK, NCA, NNC+VBM
UnRep	Unreported	CAR+FLK



Quarto Book of data and analysis (Mandy Karnauskas): https://sefsc.github.io/SEFSC-dolphin-analyses/

3a. Fishery Data

Fleet Structure

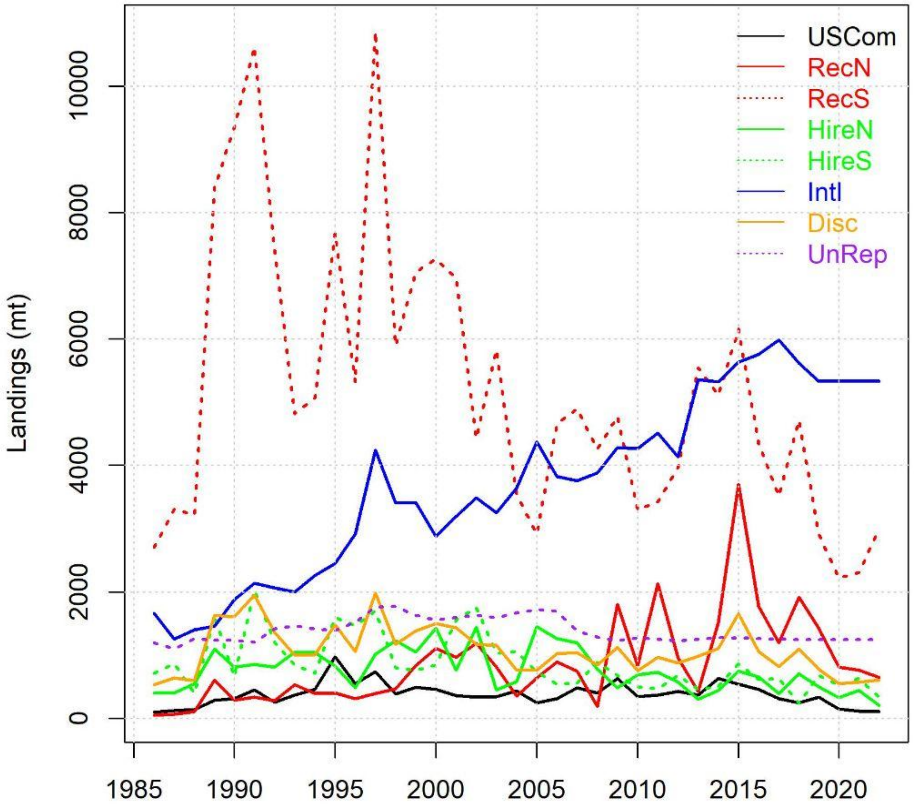
Pelagic longline logbook program initiated in 1986

Fleet structure follows stakeholder input that fishing practices vary by region and sector, and is based on existing regulations (e.g., recreational size limit in S).

[See next slide] Origins / assumptions / calculations of each data source

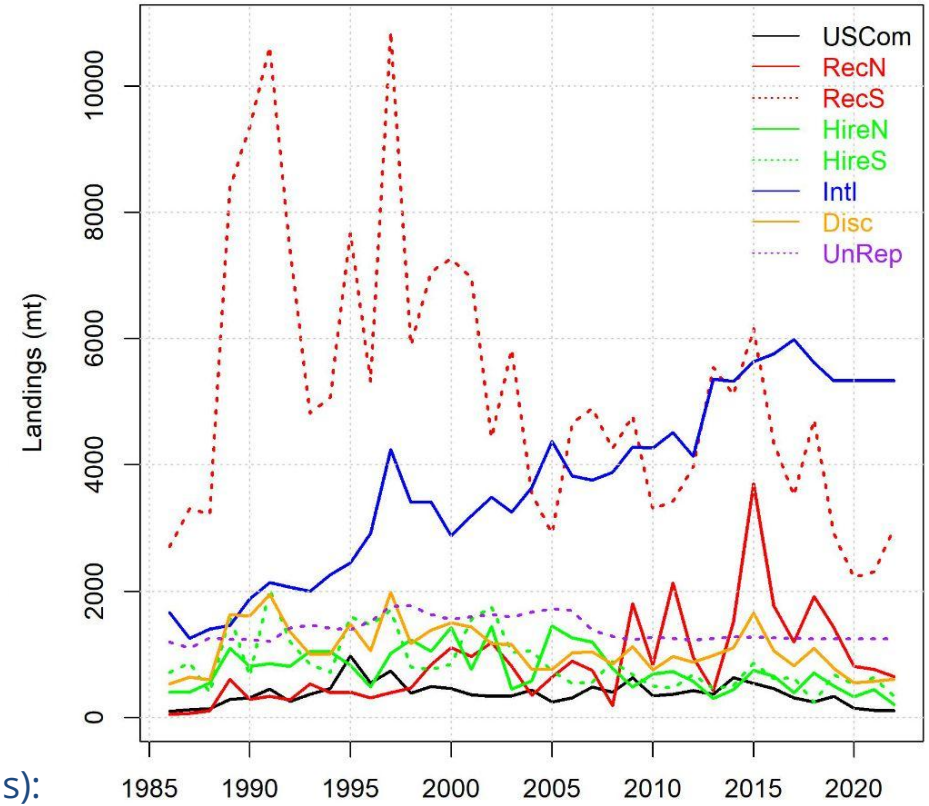
Key Trends:

Reduction in recreational fishing in the South Florida region (RecS) from highs of near 10kt in the 90's to around 3kt in 2022. During that time international catches have more than tripled from 1.5kt to 5.5kt.



3a. Catches

- Recreational landings from MRIP following ACL monitoring files for SERO (including discards)
- Commercial landings based on logbook and trip ticket databases (same data used for quota monitoring)
  - Discard rate = 1.4% and dead discard rate = 2.9% on average
- International catches based on FAO database
- Discards and unreported catches from the Sea Around Us Project (https://www.seaaroundus.org/data/)



Quarto Book of data and analysis (Mandy Karnauskas): https://sefsc.github.io/SEFSC-dolphin-analyses/

Code: https://github.com/SEFSC/SEFSC-dolphin-analyses/tree/main

3a. Fishery Data

Catches by fleet:

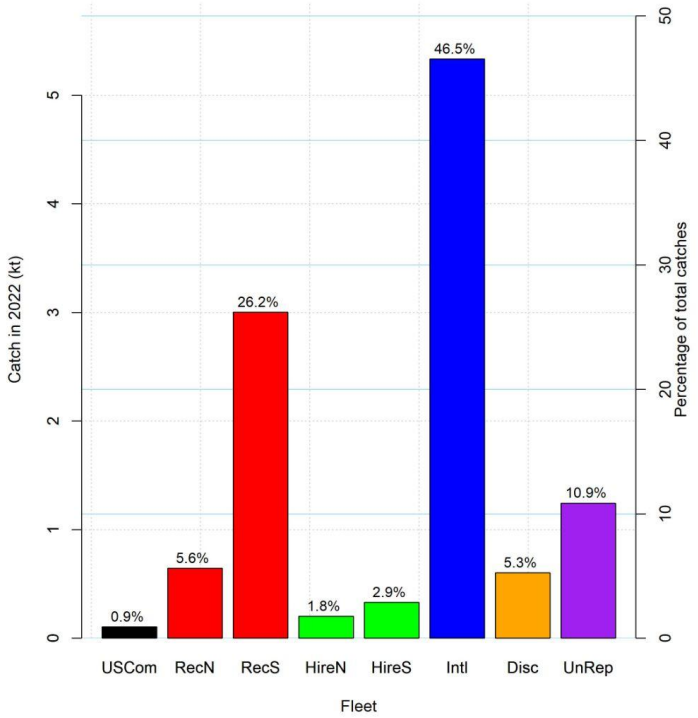
In 2022, 63% catches were from International, discard and unreported fishing activities.

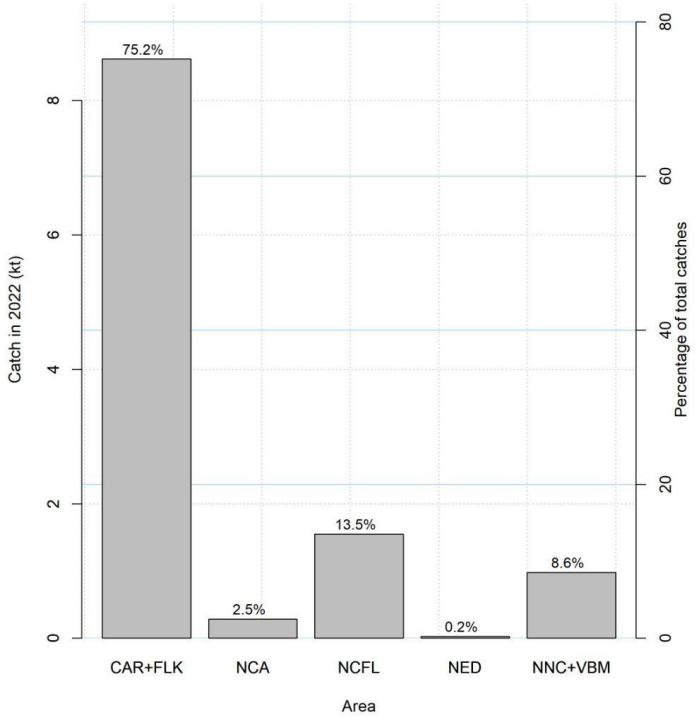
Of the remaining 37%, the majority of catches were by the S. rec. fleet (RecS) (26% of the total catches, 70% of the catch of US fleet).

The U.S. commercial fleet catches were less than 1% of the total removals in 2022.

Catches by area:

The large majority of mahi catches were taken in the Caribbean and Southern Florida region (CAR+FLK) (75%).





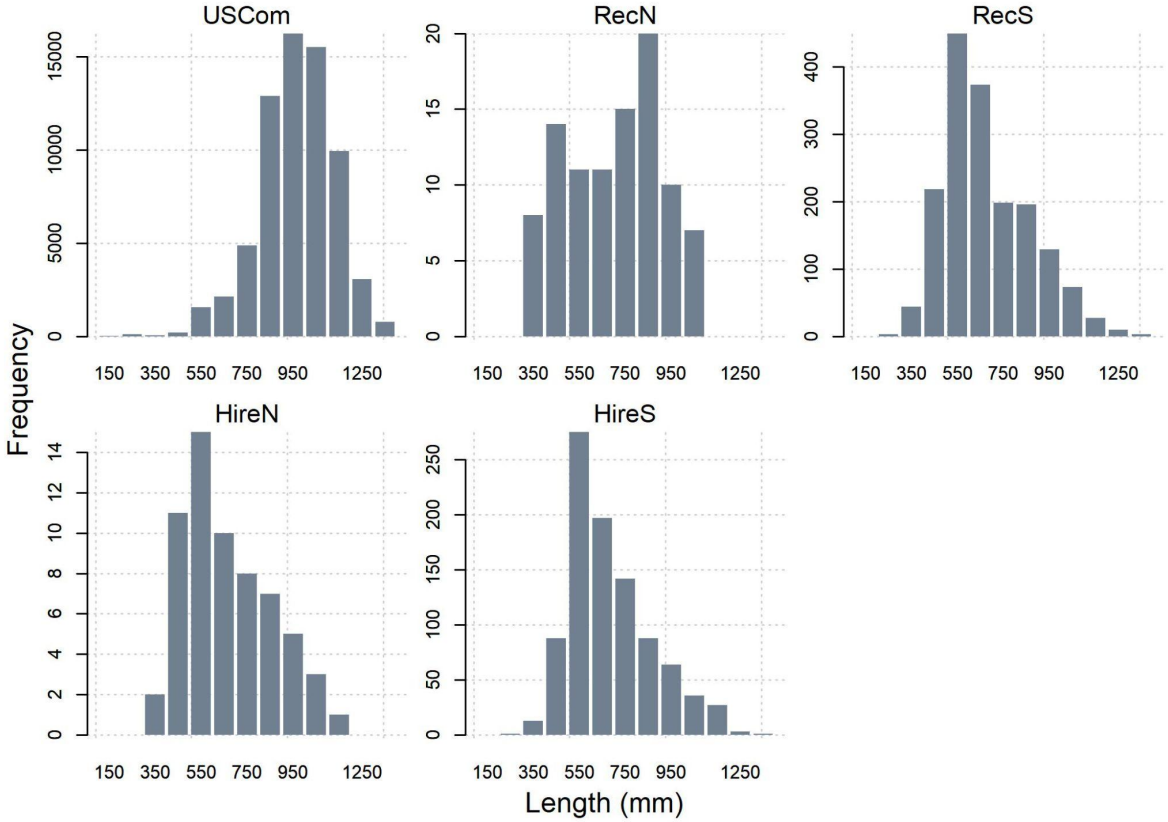
3a. Fishery Data

Catch-Length Composition

The U.S. commercial fleet catches the larger fish on average.

Much larger sample sizes for southern hire and Rec. fleets.

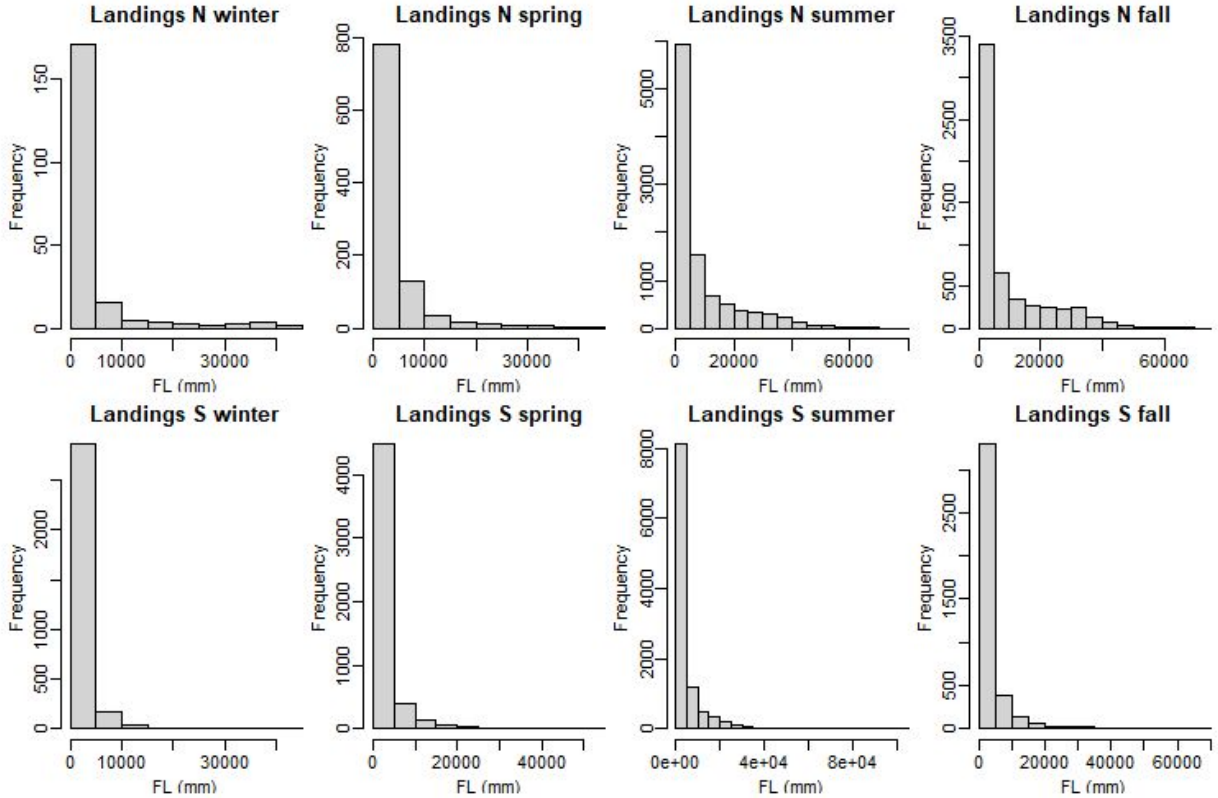
Very few samples for HireN.



3a. Fishery Data

MRIP

For use in weight-length relationship



3b. Biological Data and Parameters

Instantaneous Natural Mortality Rate, M

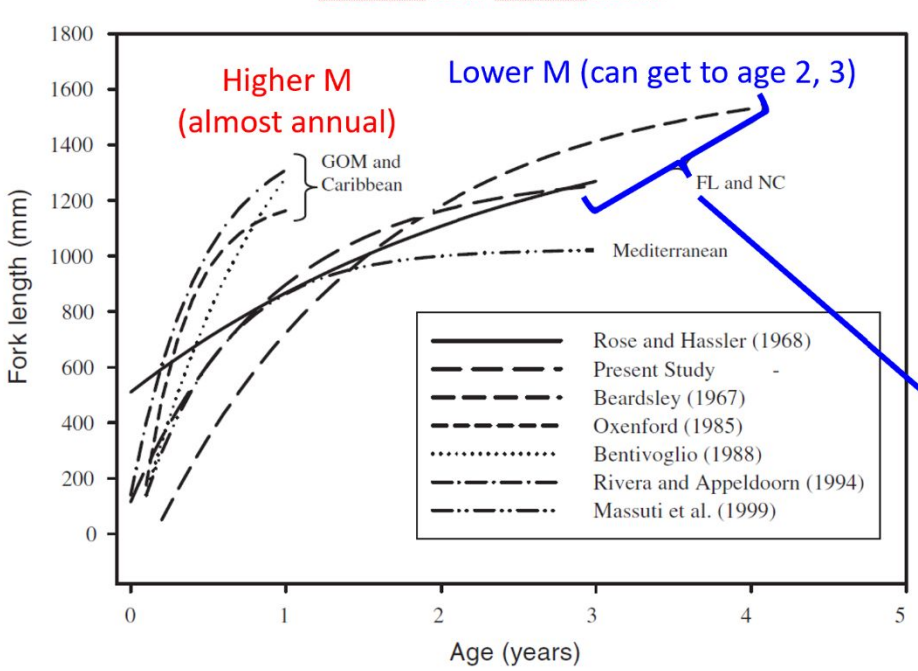
Among the most important parameters in determining stock dynamics relevant to the selection of management procedures:

- Strongly affects estimates of FMSY (overfishing reference level)
- Can strongly affect estimates of stock status (the relative impact of historical exploitation rate required to explain observations of indices and composition data - the fraction of mortality that is natural not fishing)
- Determines the number of prevalent cohorts, thereby impacting both the natural variability of biomass due to recruitment variability and the information content of composition data with regard to exploitation rate (fewer cohorts contain less information about historical exploitation levels, less contrast).
- Commonly assumed (against ecological evidence and theory) to be time-invariant, typically due to convenience (lack of ability to allow time-varying M to be estimated while time-varying exploitation rate is also estimated)
- Without extensive ancillary data (absolute abundance data, tagging) M is poorly informed
- Almost always an important axis of uncertainty among reference set operating models in MSE

3b. Biological Data and Parameters

M is highly uncertain for Dolphinfish, as is life-history in general

- Meta analyses of dolphin life-history point to very large differences among regions.



Molto et al. 2020

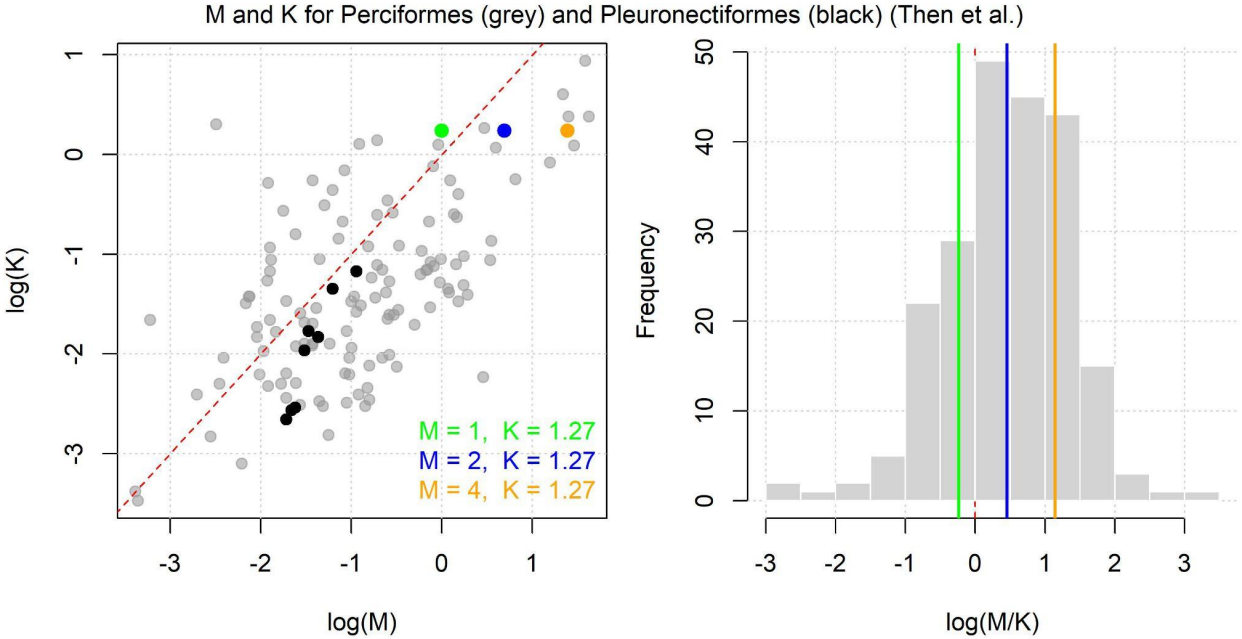
	Linf	K	
Puerto Rico	145.70	2.19	M+F
Puerto Rico	138.00	2.55	M
Puerto Rico	150.60	1.82	F
N Carolina	128.60	1.33	M
N Carolina	125.00	1.24	F
N Carolina	128.90	1.27	M+F
Brasil	194.10	0.91	M+F

3b. Biological Data and Parameters

M is highly uncertain for Dolphinfish, as is life-history in general

M/K ratios are very wide

A preliminary Bayesian analysis of conventional tagging data from a study by Martin et al. (currently not available for circulation), provided total annual Z (combined natural and fishing mortality rate) estimates of between 1.0 and 2.5 (90% interval) (the range for M is hence lower than these values depending on the assumed fishing mortality rate).



3b. Biological Data and Parameters

M is highly uncertain for Dolphinfish, as is life-history in general

- Buckel (personal. comm) in one of the only studies that age fish in Florida and North Carolina, cites the recapture of thousands of fish, rather than 10s of thousands of fish. In their aging study they aged 59 fish over 2 years of age, and 13 fish over age 3.

An M of 0.5 per quarter and 2.0 per year appears high, since at least 16,000 fish would have to be aged to obtain the 59 fish age 2+, even at the lowest exploitation rate of 0.2.

If fishery exploitation was between half and double natural mortality, and less than 10,000 fish were sampled, only relative low M scenarios that are credible.

The 13 fish age 3+ infers lower mortality (fishing mortality rate and natural mortality rate combined) for the same number of sampled fish.

	Natural mortality rate (per quarter)						
Fishing mortality rate (per quarter)	0.2	0.3	0.4	0.5	0.6	0.7	0.8
000s, of fish needed to be observed to select the 59 fish age 2+ (25 months or older)							
0.2	1	3	7	16	36	78	172
0.3	3	7	16	36	78	172	378
0.4	7	16	35	78	172	378	829
0.5	16	35	78	173	379	832	1820
0.6	35	78	173	381	835	1830	4000
0.7	79	173	382	840	1841	4029	8801
0.8	174	384	845	1854	4061	8879	19383
000s fish needed to be observed to select the 13 fish age 3+ (37 months or older)							
0.2	2	5	18	59	193	633	2072
0.3	5	18	58	192	632	2072	6777
0.4	18	58	192	632	2073	6789	22184
0.5	58	192	632	2076	6807	22266	72683
0.6	192	633	2081	6830	22366	73083	238354
0.7	634	2087	6859	22483	73539	240071	782378
0.8	2096	6893	22617	74051	241967	789258	2570443

Sample Nos between	1	20
		thousand
frac. Taken	seasonal F	
0.6	0.229073	
0.9	0.575646	

this is 2.57 billion fish

3b. Biological Data and Parameters

Instantaneous Natural Mortality Rate, M

In this MSE, M was specified based on the following basis

- Should encompass a wide range.
- Should not contradict the study by Schwenke and Buckel (2008) that collected the most directly relevant data (Florida and Carolina) to overall mortality rate: age samples.

Values of annual M in the range of 1.0 (0.25 per quarter) to 2.0 (0.5 per quarter) were considered for the specification of reference set operating models).

Discard Mortality

Rudershausen et al. (2019) estimated a rate of 0.248 for hook and line fishing in the U.S. South Atlantic

A length-invariant rate of 0.25 was the default value of the mahiMP (treated as a management lever).

3b. Stock-Recruitment and Resilience

! THIS IS UNKNOWN !

Typically derived from stock-specific estimates of spawning stock biomass (preferably informed by an independent survey) and estimates of recruitment (preferably informed by age-composition data).

It can be argued that resilience is determined by both ecology and life-history and are not necessarily predicted well from similar species elsewhere.

Life-history theory and evolutionary theory suggests that, in general, shorter-lived species require higher resilience due to higher probability of spawning collapse due to fewer cohorts and greater natural variability.

Assumed elsewhere:

Eastern Atlantic Dolphinfish: Aires da Silva et al. 2021 (cited by Roa-Ureta et al. 2021). Beverton-Holt, assumed a value of h = 1 (no impact of spawning biomass on recruitment, MSY reference points unavailable)

North western Pacific Dolphinfish: Wang et al. (2026) present MSE results for a low-steepness scenario assuming Beverton-Holt dynamics and a steepness value of 0.7.

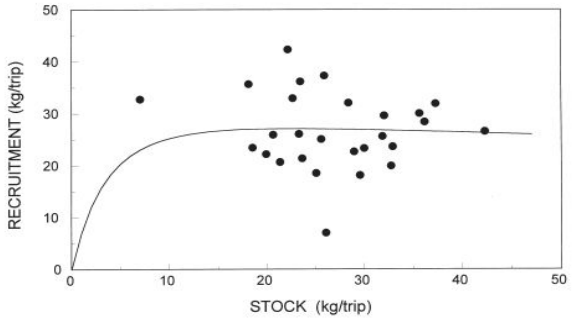


FIG. 8. – Recruitment versus stock for dolphinfish in the eastern Caribbean, based on a detrended catch rate time-series from Barbados. A Shepherd curve is shown.

3b. Biological Data and Parameters

Somatic Growth

Paucity of recent paired age and length data. Relied on the FL and NC study of Schwenke Buckel (2008) who characterized von Bertalanffy growth parameters for males and females combined:

Asymptotic Length = 1289mm (St.dev. 25.95mm)

Max. Growth rate = 1.27 (annual) (St.dev. 0.08)

Age at zero length (t0) = -0.026

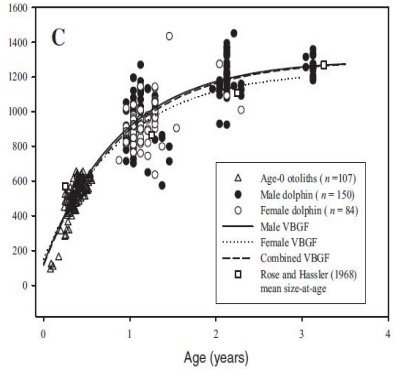
CV of length at age = 0.15 (data rip Fig 2 of S&B)

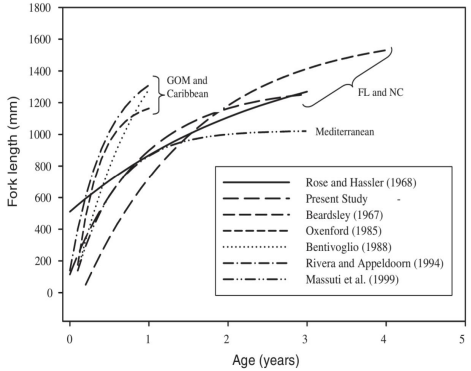
The operating models of the mahiMSE framework include uncertainty in the mean somatic growth curve, taking the variance estimates provided by Schwenke and Buckel (2008).

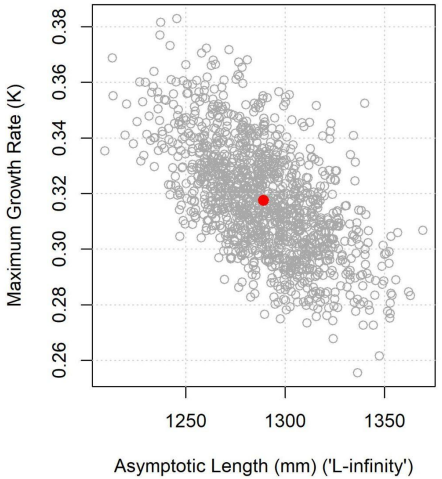
Based on the typical negative correlation among these parameters in meta databases such as fishbase, these are sampled with a negative correlation of -0.6.

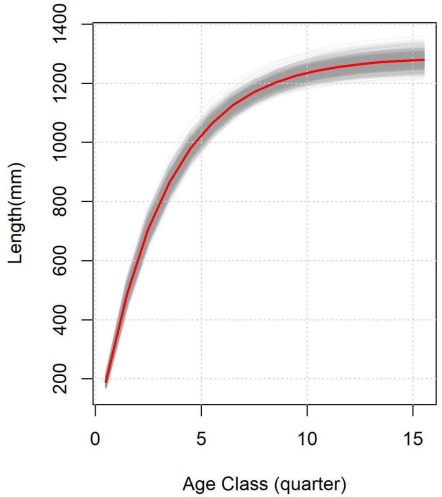
The uncertainty in length at age was estimated to be approximately 0.15 based on a data rip of S&B Figure 2.

Figures 2 and 3 from Schwenke and Buckel 2008









3b. Biological Data and Parameters

Weight (W) at length (L) relationship (kg from mm).

$W = \alpha L^{\beta}$

In this case maximum likelihood estimates of these parameters fitted to the most recently available MRIP data:

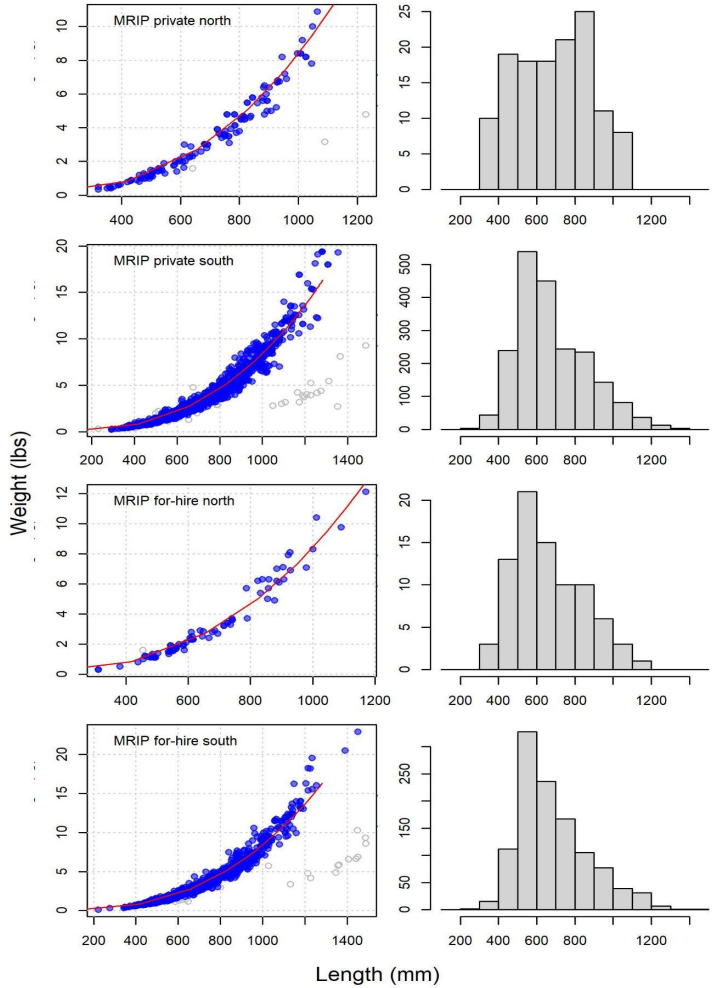
α = 8.2E-8

β = 2.67

Schwenke and Buckel (2008) estimated β = 2.64 but this did not fit the recent MRIP data as well.

Fortunately these are more or less nuisance parameters. In most fishery models this impacts only the estimation of unfished recruitment - the 'numbers scale' of the model, not the biomass.

Generally we are less concerned with absolute numbers.



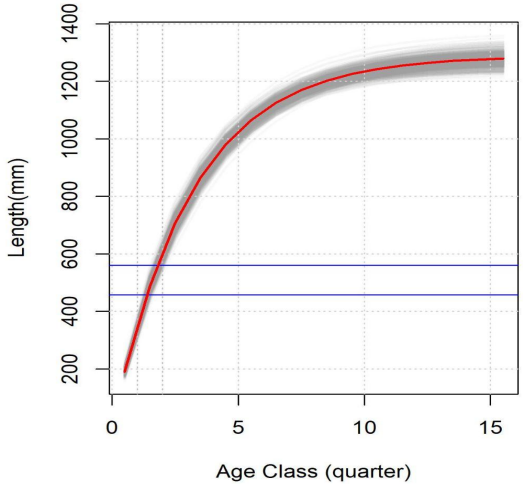
3b. Biological Data and Parameters

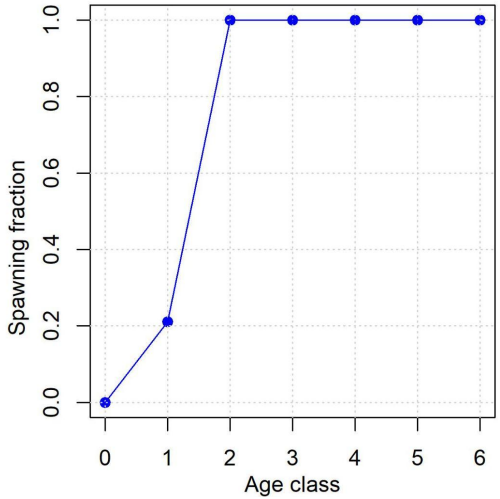
Spawning fraction at age (‘maturity at age’)

From Schwenke and Buckel (2008): "Males reached 50% maturity at 476 mm FL and 100% maturity was reached at 645 mm FL (Table 3). Females reached 50% maturity at a slightly smaller size than males, although confidence limits for this parameter overlapped with those of males. At 458 mm FL, 50% of female dolphinfish were mature, and 100% were mature at about 560 mm FL"

As is typical in single-stock models, spawning biomass is characterized by female parameters (assuming female biomass is limiting recruitment). Hence the following parameters are assumed:

Length at 50% spawning fraction (L50) (female) (mm) = 458 (Deterministic)





3c. VAST Index

Spatial Domain ‘Western Atlantic Ocean’

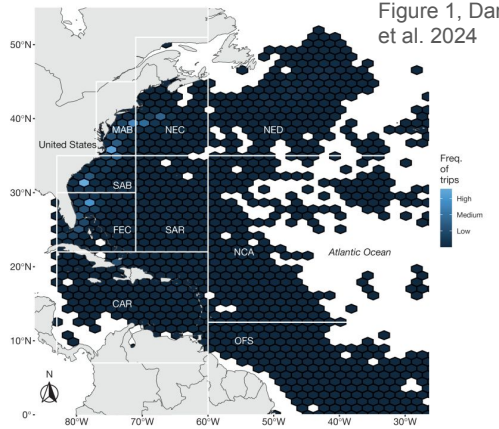


Figure 1, Damiano et al. 2024

Seasonal Species Distribution Model developed by [Damiano et al. 2024]

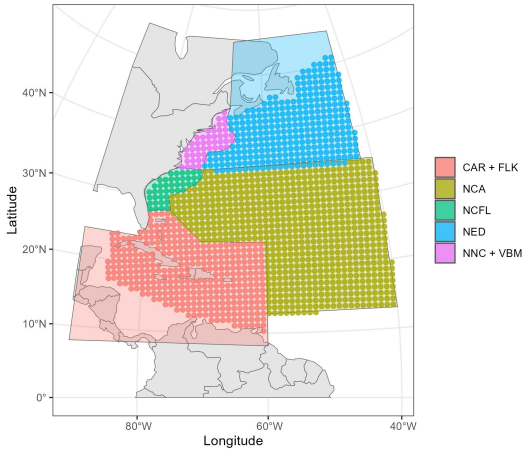
Fitted to catch rate logbook data of the U.S. pelagic longline supplied by NMFS.

37 years of data from 1986 - 2022

No. fish per hook as unit of catch-per-unit-effort

4 season model (Dec-Feb, Mar-May, Jun-Aug, Sept-Nov)

Model estimates of spatial biomass distribution can be aggregated post-hoc.



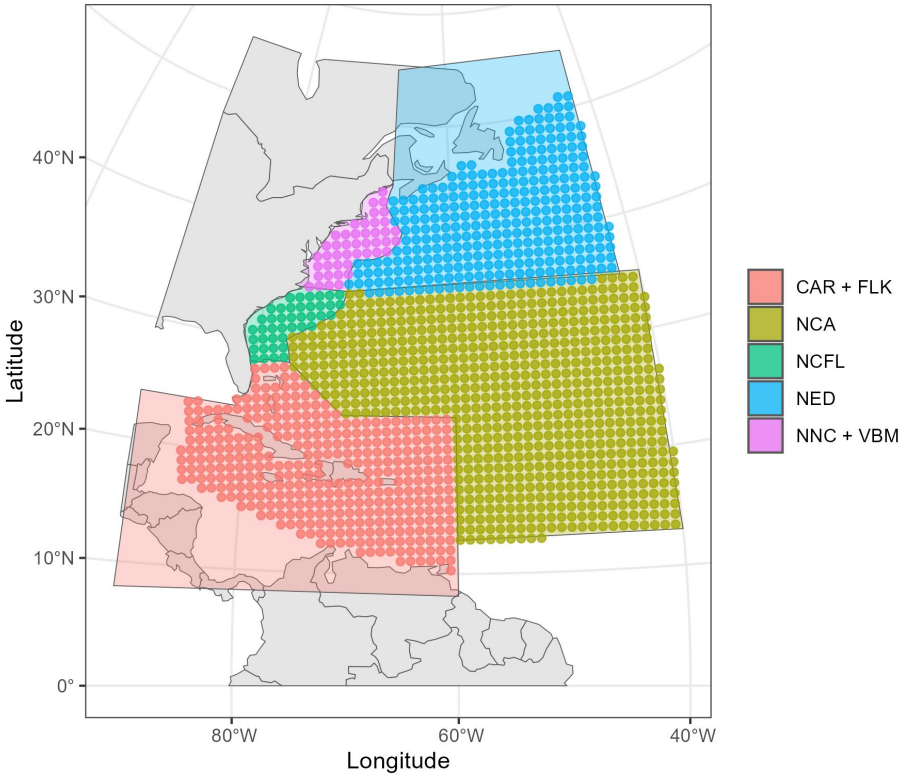
Model Configuration

For OM, re-summarized VAST model with 5-area definition (bottom)

3c. VAST Index

Requirements of Area Definitions

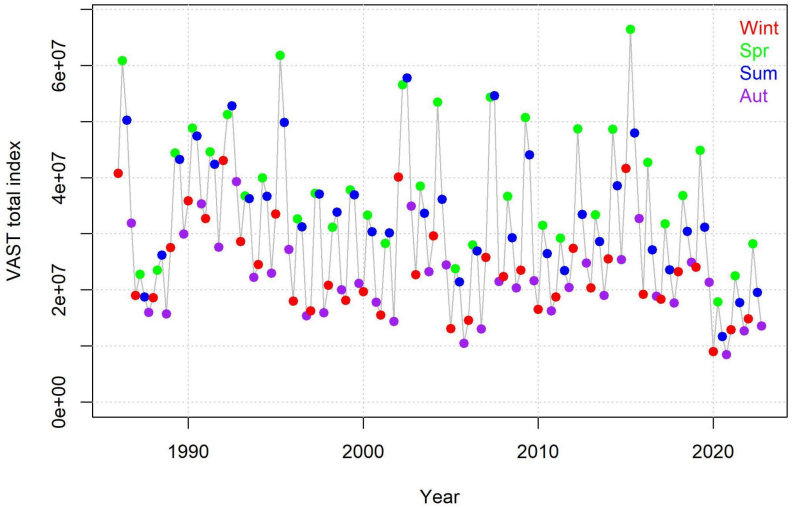
- Needed to capture heterogeneity in seasonal stock availability (more available and more seasonally consistent in CAR+FLK than NCFL and NNC+VBM for example)
- Along with fleet structure designation, needed to meet stakeholder-defined, regionally-varying properties of fishery

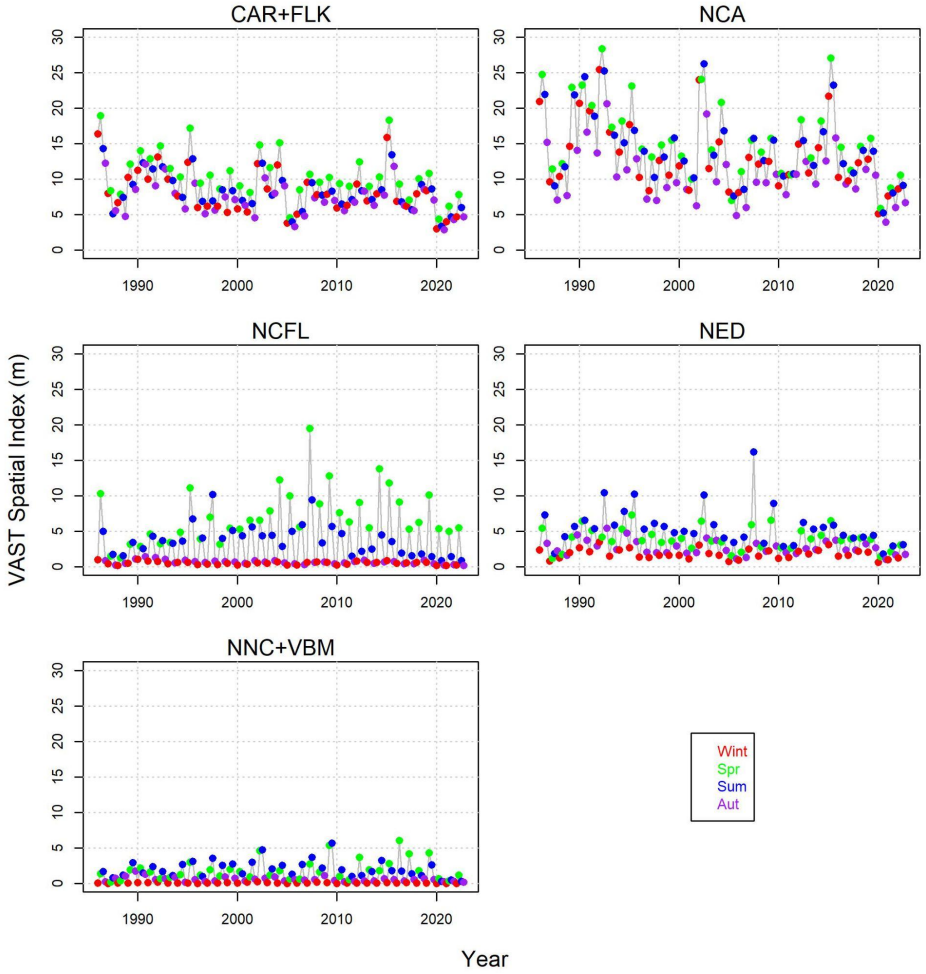


3c. VAST Index

Key Index Properties

- Overall seasonality
- Early ‘low period’
- Late ‘low period’
- High spatial heterogeneity
- Varying degree of seasonality by area (e.g. higher and more consistent in CAR+FLK)

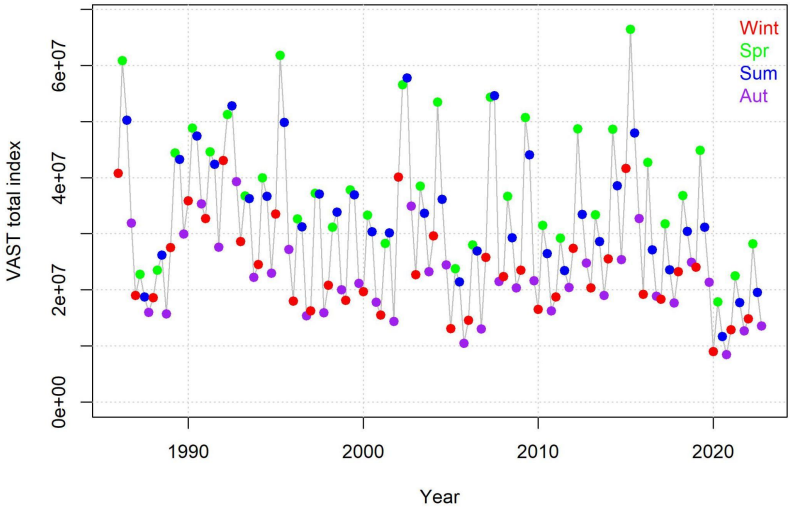


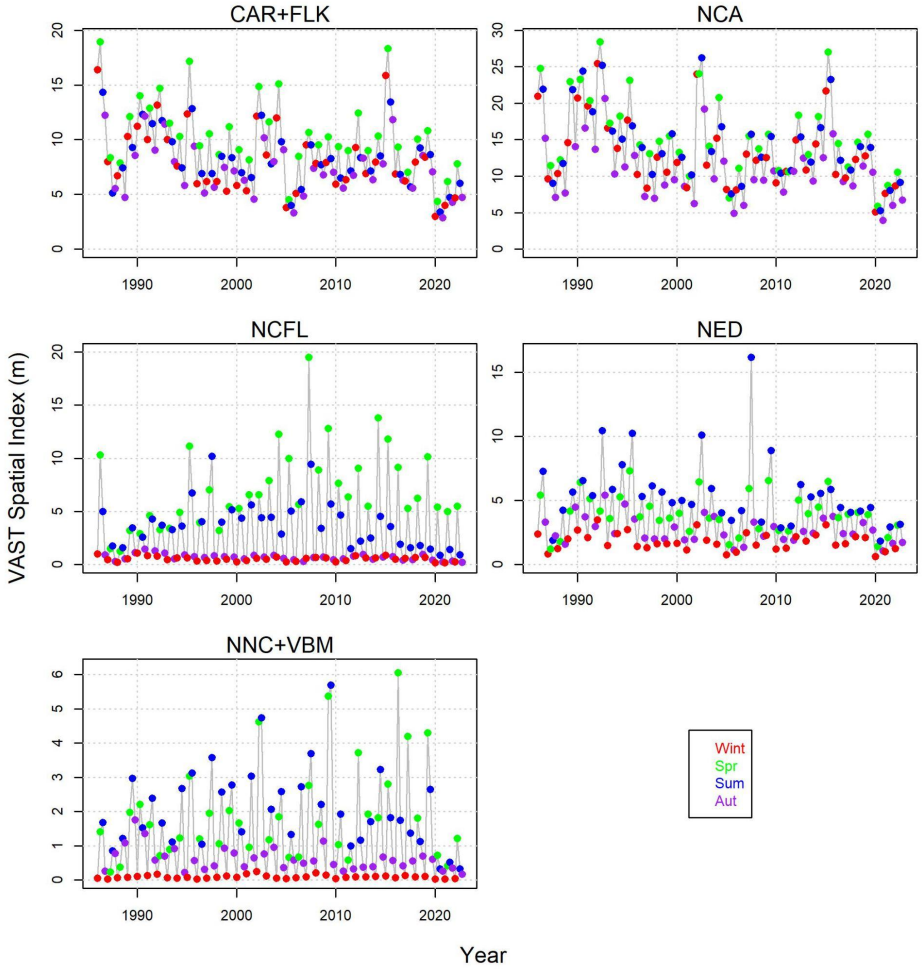


3c. VAST Index

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Summary

Exploitation

- Varying catch-length distribution among fleets
- Majority of exploitation is non-U.S. fleets (almost double the U.S. catch)
- Large majority of catches are in the Florida and Caribbean area
- Commercial catches are relatively small (less than 1% of total catches in 2022)

Biological Inputs (M, growth, maturity)

- Use of data and parameters from Florida and North Carolina studies (S&B 2008)
- Uncertainty in M, steepness, growth and maturity are to be included in OMs
- Discard mortality: Length - invariant 25% (of Rudershausen et al. 2019)

Index

- Aggregate and spatially disaggregated indices available
- Spatial-heterogeneity (more in S.), seasonality varies among areas (more Var, in N.)

Key references

Mahon, R. Oxenford, H.A. 1999. Precautionary assessment and management of dolphinfish in the Caribbean. Scientia Marina. 63(3-4): 429-438

Molto V. et al. 2020. A global review on the biology of the dolphinfish (*Coryphaena hippurus*) and its fishery in the Mediterranean Sea: advances in the last two decades. Reviews in Fisheries Science and Aquaculture. 28 (3): 376-420.

Roa-Ureta, R.H., et al. 2021. Stock Assessment of the Dolphinfish (*Coryphaena hipparus*) in the South-East Pacific Ocean.

Rudershausen, P.J., Poland, S.J., Merten, W., Buckel, J.A., 2019. Estimating Discard Mortality for Dolphinfish in a Recreational Hook and Line Fishery. N. Am. J. Fish. Manage. 39(6): 1143-1154.

Schwenke, K.L., and Buckel, J.A. 2008. Age, growth, and reproduction of dolphinfish (*Coryphaena hippurus*) caught off the coast of North Carolina. Fish. Bull. 106:82–92

Wang, S-P. et al. 2026. Toward sustainable use of dolphinfish (Coryphaena hippurus) in the Northwest Pacific: A framework for stock assessment and management strategy evaluation. Regional Studies in Marine Science, 94

Applicable TORs

1. Evaluate the types and ranges of uncertainty used in the MSE. Explicitly consider uncertainty in data, life history, process error, nonstationarity (i.e., environmental variability and oceanographic changes), and if appropriate, fishery dynamics.
    a. Were selected axes of uncertainty relevant to the stock and fishery and appropriately characterized? If relevant, were uncertainties highlighted by managers and stakeholders included?
    b. Did levels of uncertainty for each axis meaningfully and reasonably encompass plausible uncertainty?
    c. Were uncertainties appropriately classified into reference (primary) or robustness (secondary) set and sufficiently explained?