



**NOAA
FISHERIES**

Stock Assessment Building Blocks

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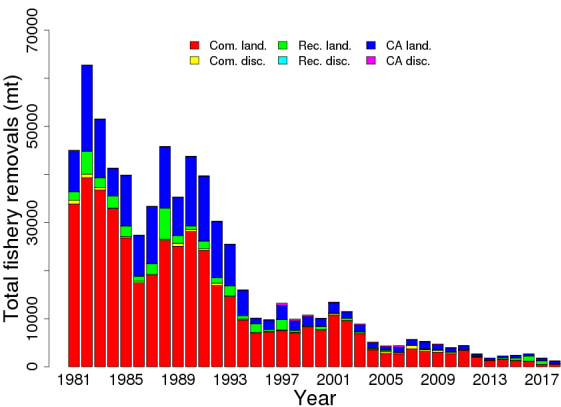
Presentation to Cod Stock Structure Workshop



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Building Blocks Take Home

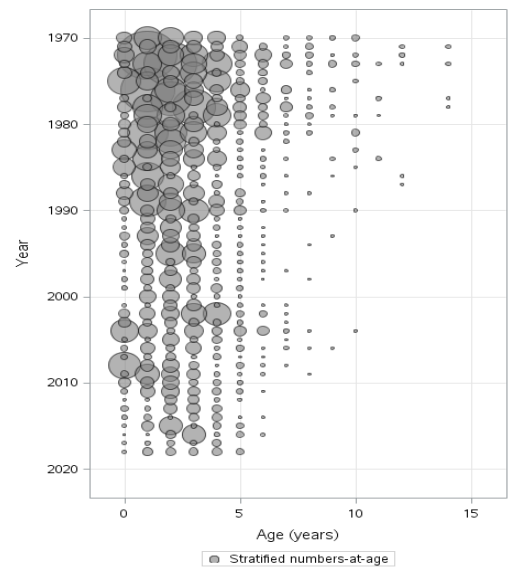
- Representative
- Stratified
- Challenges



Large Mesh Otter Trawl

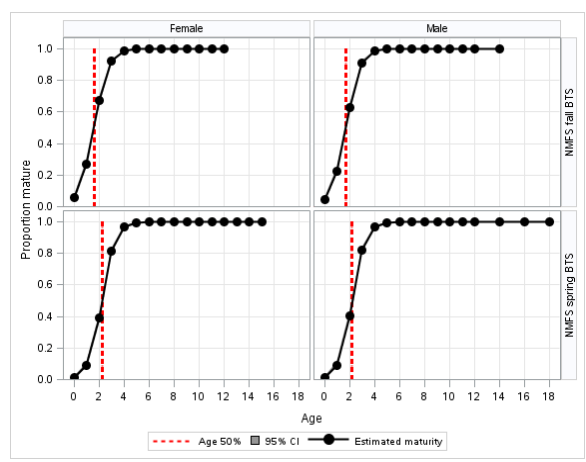
Year	WGB			EGB			SNE		Total Disc mt	Total Prop Dead	Total Dead mt	
	mt	cv	# trips	mt	cv	# trips	mt	# trips				
1989	606.7	0.28	25	100.0	0.45	12	41.9	0.00	4	749	0.75	561
1990	431.8	0.35	23	92.0	0.38	10	28.8	0.61	17	553	0.75	414
1991	302.8	0.48	28	149.0	0.74	4	0.0	0.00	9	452	0.75	339
1992	147.5	0.52	26	232.0	0.42	11	0.9	0.83	9	380	0.75	285
1993	92.9	0.52	18	73.0	0.57	13	7.4	0.00	15	173	0.75	130
1994	87.1	0.86	20	5.0	1.17	15	0.0	0.00	12	92	0.75	69
1995	52.9	0.48	42	0.0	0.61	15	0.0	0.00	24	53	0.75	40
1996	20.4	0.36	17	1.0	0.38	9	0.3	0.51	21	22	0.75	16
1997	19.1	0.30	16	0.0	0.00	0	0.4	0.75	12	20	0.75	15
1998	6.6	0.61	5	2.0	0.00	3	0.0	0.00	5	9	0.75	6
1999	35.3	0.56	12	12.0	0.00	4	0.0	0.00	10	47	0.75	35
2000	66.7	1.04	21	21.0	0.45	10	0.0	0.00	11	88	0.75	66
2001	150.8	0.59	34	195.0	0.70	11	0.0	0.00	18	346	0.75	259
2002	75.5	0.33	69	12.0	0.49	22	0.0	0.00	13	88	0.75	66
2003	116.9	0.21	142	104.0	0.51	68	0.0	0.00	14	221	0.75	166
2004	51.1	0.19	193	69.0	0.51	67	0.3	0.59	108	120	0.75	90
2005	225.2	0.12	649	254.0	0.13	93	1.0	0.53	270	480	0.75	360
2006	155.7	0.18	342	125.0	0.23	40	0.2	1.16	106	281	0.75	211
2007	563.9	0.11	347	354.0	0.31	49	1.9	0.94	100	920	0.75	690
2008	354.8	0.10	446	26.0	0.19	123	0.1	0.97	114	381	0.75	286
2009	250.6	0.13	380	194.0	0.19	116	25.8	0.78	147	470	0.75	353
2010	160.8	0.11	436	129.0	0.50	87	31.4	1.47	141	321	0.75	241
2011	94.8	0.10	532	25.0	0.04	134	29.4	0.22	296	149	0.75	112
2012	77.4	0.13	379	68.0	0.31	83	2.1	0.26	242	148	0.75	111
2013	62.6	0.13	312	18.0	0.22	43	17.8	0.29	295	98	0.75	74
2014	14.2	0.09	331	2.0	0.26	42	2.9	0.47	395	19	0.75	14
2015	26.7	0.15	269	5.8	0.36	59	1.8	0.28	314	34	0.75	26
2016	24.0	0.15	166	5.4	0.55	31	2.8	0.52	214	32	0.75	24
2017	18.0	0.32	166	2.4	0.24	33	0.5	0.66	245	21	0.75	16
2018	5.9	0.24	103	2.4	0.23	22	0.9	0.46	241	9	0.75	7

NMFS fall BTS



Year	comland	comdisc	recland	recdisc	Caland	Cadisc	total
1981	33849	775	1796	3	8508	98	45029
1982	39333	739	4790	2	17827	71	62762
1983	36756	492	2103	7	12131	64	51554
1984	32915	74	2501	2	5761	68	41321
1985	26828	262	2220	6	10442	103	39861
1986	17490	343	976	2	8504	51	27366
1987	19035	200	2228	12	11844	76	33395
1988	26310	242	6445	12	12741	83	45833
1989	25056	628	1634	20	7895	76	35309
1990	28110	453	758	19	14364	70	43775
1991	24219	358	1584	7	13467	65	39700
1992	16899	515	1103	17	11667	71	30272
1993	14590	163	2098	74	8526	63	25513
1994	9737	166	717	33	5277	63	15992
1995	7026	85	1820	62	1102	38	10133
1996	7261	114	388	22	1924	56	9765
1997	7548	107	2127	40	2919	486	13226
1998	7041	113	422	64	1907	365	9912
1999	8313	81	194	26	1818	338	10770
2000	7600	134	667	57	1572	69	10099
2001	10749	308	94	20	2143	143	13457
2002	9472	167	458	37	1278	94	11506
2003	6852	229	265	35	1317	200	8898
2004	3508	130	210	21	1112	145	5127
2005	2754	394	325	23	630	226	4352
2006	2700	232	36	6	1097	350	4421
2007	3699	728	23	31	1107	117	5705
2008	3255	309	208	3	1390	140	5305
2009	2999	385	142	9	1003	206	4744
2010	2688	253	195	27	748	94	4005
2011	3387	122	142	25	702	43	4421
2012	2007	120	81	3	395	75	2681
2013	1312	83	7	2	384	39	1828
2014	1514	19	257	19	430	28	2267
2015	1300	31	486	71	472	20	2380
2016	1109	33	1075	32	428	12	2690
2017	464	20	785	25	474	14	1782
2018	574	13	66	6	510	7	1176

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12
1978	1	8	108	3,644	1,167	394	163	127	22	23	6	2	1
1979	1	15	890	735	1,520	543	182	74	61	11	3	2	1
1980	2	6	973	1,650	301	968	354	97	26	46	16	4	1
1981	3	35	860	1,865	1,337	279	475	181	96	59	21	2	1
1982	0.01	15	3,516	1,971	1,269	1,087	196	399	155	49	14	22	6
1983	10	22	783	2,510	1,297	562	398	118	182	102	25	28	12
1984	0.1	17	231	805	1,354	546	377	279	39	90	38	17	7
1985	33	9	2,861	1,409	661	987	271	110	110	21	27	3	4
1986	1	41	451	2,266	588	343	456	68	48	29	4	8	1
1987	2	22	4,116	846	1,148	163	132	174	41	24	8	3	1
1988	1	23	289	4,189	680	855	130	116	182	52	21	13	4
1989	1	18	690	811	1,983	228	373	56	40	59	15	7	5
1990	1.1	16	728	3,109	1,038	1,374	145	152	12	12	24	3	2
1991	0.4	63	991	1,008	1,927	904	746	105	69	21	11	8	4
1992	-	68	2,581	1,379	460	889	314	315	45	34	3	5	2
1993	-	10	501	1,894	909	299	359	133	97	25	17	3	0.0
1994	1	6	182	483	788	270	45	61	30	21	2	1	-
1995	3	1	57	237	94	105	18	7	4	4	0.1	0.08	0.00
1996	0.1	5	40	234	398	79	60	13	4	3	0.3	0.1	-
1997	1	9	148	205	358	358	84	37	13	4	1	1	0.0
1998	0.1	5	101	314	161	158	134	23	13	4	1	0.3	0.0
1999	0.1	9	79	483	337	109	61	57	14	2	1	0.08	-
2000	1	3	62	110	380	151	37	22	12	3	0.2	0.3	0.00
2001	1	3	107	511	211	398	105	32	17	7	1	0.3	0.0
2002	1	1	10	125	447	108	156	30	9	6	2	1	0.2
2003	13	-	35	148	243	405	81	89	19	4	1	0.3	-
2004	-	23	12	140	151	147	139	35	30	7	1	1	0.2
2005	-	4	71	45	201	50	34	35	10	5	1	0.02	0.1
2006	-	3	19	226	78	195	48	18	18	2	0.2	0.3	0.1
2007	0.005	2	53	62	421	34	85	11	7	7	2	0.4	0.1
2008	-	1	45	141	61	249	15	33	4	2	1	0.1	-
2009	1	7	43	200	139	46	137	9	10	1	1	0.05	-
2010	0.02	3	44	96	211	74	15	35	3	2	0.3	0.04	0.00
2011	-	9	43	76	93	115	26	12	7	0.2	0.2	0.006	-
2012	-	2	70	105	49	29	25	6	1	1	0.02	-	-
2013	0.5	1	27	112	52	11	7	2	0.4	0.03	0.08	-	-
2014	-	4	17	82	103	28	4	0.3	0.1	-	-	-	-
2015	-	1	67	38	71	47	6	1	0.03	0.03	0.3	0.002	-
2016	-	4	15	99	37	32	21	3	0.2	0.001	-	-	-
2017	0.04	0.5	12	43	92	10	15	5	1	0.005	-	-	-
2018	-	5	14	27	52	67	5	5	3	0.07	-	0.004	-



Catch

- How many fish were removed from the population by fishing?
- Commercial
 - Landings
 - Discards
- Recreational
 - Landings
 - Released but died
- Other countries

A Commercial Trip

- Pre-Trip Notification System or similar
 - Observer or not – estimate discards
- Go fish
 - Record catch in Vessel Trip Report – where fishing
 - Electronic monitoring perhaps – confirm discards
- Land fish
 - Sell to dealer(s) (Dealer reports)
 - Port samplers may collect length/age samples
- Challenges
 - Matching all the data from this trip (and all the other trips)
 - Estimating discards when not observed
 - Fishing in multiple areas on one trip

Recreational Data

- Marine Recreational Information Program
- Mail and telephone surveys for effort
- Intercept survey at docks for catch/effort
- $\text{Effort} * \text{catch/effort} = \text{catch}$
- Challenges
 - Lots of recreational fishing and landing points
 - Based on where landed not where fished
 - Fate of released fish (and how many released)

Tons to Numbers at Age

- Length samples convert catch in weight to catch in numbers at length
 - Three 50 cm fish in 40 kg sample -> 3,000 50 cm fish in 40 metric ton catch
- Age samples tell proportion at age for each length
 - Three fish age 5 and two fish age 6 at 50 cm means 3,000 50 cm fish split into 1,800 age 5 and 1,200 age 6
- Why age?
 - Accounts for growth of fish during year and different cohort sizes

Tons to Numbers at Age II

- Representative
 - Time – growth
 - Gear – selectivity
- Stratification
 - Market categories (landings)
 - Gear groups (discards)
 - Quarter or half year
- Challenges
 - Grouping data
 - Filling holes

Surveys

- Consistent gear and effort
- Track changes in population
 - Often relative abundance
 - Survey catchability allows absolute abundance
- Also provide biological information
 - Maturity and diet data
 - Length, weight, age samples
- Challenges
 - Sample size
 - Spatial coverage (availability)

What about CPUE?

- Catch per unit effort from fishing fleet
 - Sometimes landings per unit effort (LPUE)
- Can also be used to measure change in fish population
- Challenges
 - Change in CPUE may be due to factors other than change in population
 - CPUE may not change when population does
 - Tradeoff between consistent and representative trips

Other Building Blocks

- Directed studies for biology or fishery
 - Maturity/fecundity
 - Growth (length at age and weight at length)
 - Selectivity
 - Natural mortality (really difficult)
 - Release (discard) mortality rate
 - Movement
- Cooperative research between fishermen and scientists key to getting these studies right
- Challenges
 - Changing environment
 - Time and money to conduct studies

What does this mean for cod?

- Changing stock definitions requires recreating full time series of catch, survey, biological, and fishery information
 - Not an automated process
 - Requires human oversight and decision making
 - Data collected under one set of stock definitions may not be appropriate or sufficient for another set of stock definitions
 - More stocks means less data per stock
 - Low catch and population size means less data collected regardless of stock definitions
- Important to get stock definitions right because using wrong stock definitions can lead to poor management (simulation studies)

Building Blocks Take Home

- Representative
- Stratified
- Challenges

Questions?