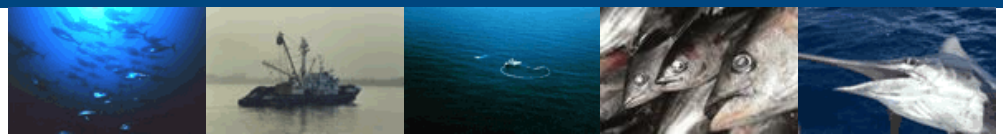
NOAA FISHERIES
Southeast Fisheries Science Center

Overview of ICCAT*
Atlantic Highly Migratory Species Stock Assessment Process

including examples of
SEFSC HMS research in the Gulf of Mexico

*International Commission for the Conservation of Atlantic Tunas

Migratory Species Committee
Gulf of Mexico Fishery Management Council
January 30, 2017



ICCAT is responsible for the management of tunas and tuna-like species in the Atlantic Ocean and adjacent seas. In practice, along with bycatch species, this includes:

- Atlantic Bluefin
- Bigeye
- Skipjack
- Yellowfin
- Albacore
- Swordfish
- White Marlin
- Blue Marlin
- Sailfish
- Spearfishes

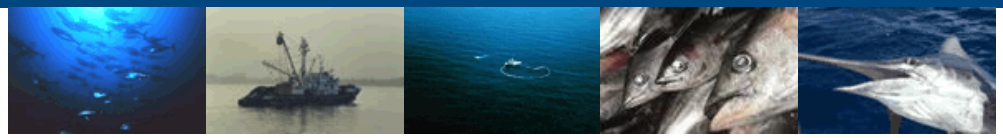
Pelagic Sharks, such as

- Blue Shark
- Shortfin Mako
- Porbeagle

U.S. domestic regulations for HMS cannot conflict with measures negotiated and adopted by ICCAT.
(But domestic regs can be used to ensure compliance/allocation *e.g.* size/bag limits, time/area closures).

Although not yet assessed. . .

- Spanish Mackerel
- King Mackerel
- small tunas (e.g. Black Skipjack, Frigate Tuna, Atlantic Bonito)

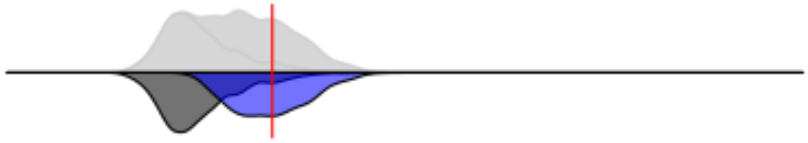


ICCAT's Standing Committee on Research and Statistics (SCRS), on which every member of the Commission may be represented, is responsible for providing scientific advice to the Commission

- **Defining procedures** for the collection, compilation, analysis and dissemination of fishery statistics
- **Conducting research** with a principal focus on the effects of fishing on stock abundance
- **Planning/Coordinating** various national and international cooperative research programs
- Carrying out **stock assessments** and providing **management advice**

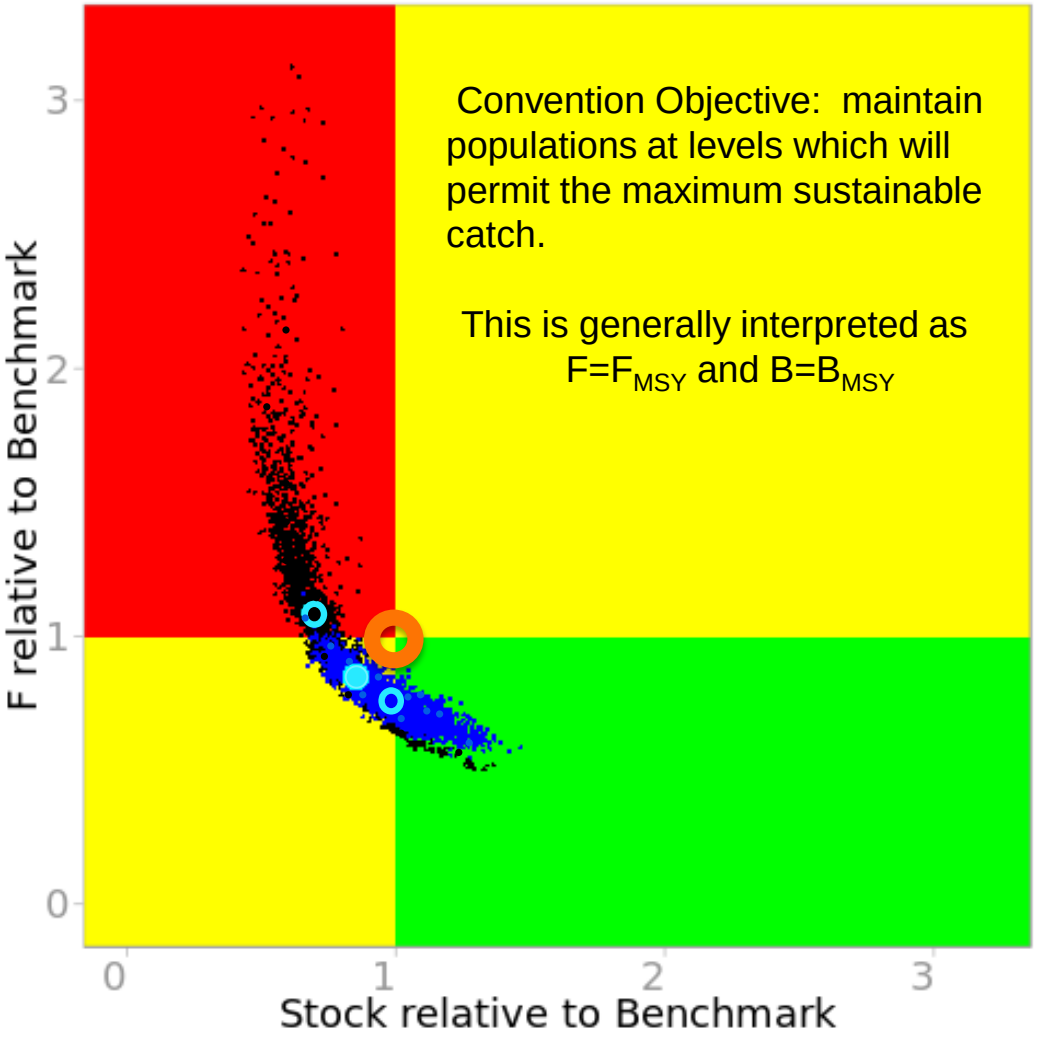
The ICCAT SCRS acts like an SSC and SEDAR combined: it conducts research and analyses, reviews results and conclusions, and delivers the scientific advice (periodically with independent reviewers), however the Commission is not compelled to follow the SCRs advice (and often doesn't).

Example of current stock status plot



Overfished

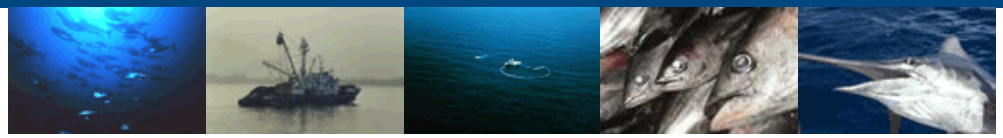
Overfishing



Example of management strategy matrix

Probability of green status ($B>B_{MSY}$ and $F<F_{MSY}$)

Catch (t)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
12,000	74%	80%	94%	95%	95%	96%	96%	96%	96%	96%	96%	96%	96%	
14,000	74%	78%	93%	94%	95%	95%	95%	96%	96%	96%	96%	96%	96%	
16,000	73%	77%	90%	93%	94%	94%	95%	95%	95%	95%	95%	95%	95%	
18,000	68%	72%	83%	89%	91%	92%	92%	93%	93%	93%	93%	94%	94%	
20,000	63%	65%	71%	81%	83%	84%	84%	85%	86%	86%	86%	87%	87%	
22,000	62%	63%	65%	73%	78%	79%	79%	79%	80%	80%	80%	80%	80%	
24,000	61%	60%	60%	63%	69%	72%	72%	72%	71%	71%	70%	70%	69%	
26,000	55%	54%	53%	52%	52%	55%	56%	57%	56%	55%	54%	53%	52%	
28,000	48%	45%	42%	40%	37%	35%	35%	35%	35%	35%	35%	35%	35%	
30,000	39%	35%	33%	30%	28%	26%	24%	23%	21%	20%	19%	18%	18%	
32,000	32%	29%	26%	24%	22%	19%	17%	16%	14%	13%	12%	11%	11%	
34,000	28%	25%	22%	19%	15%	13%	11%	9%	8%	7%	7%	6%	6%	
														Average catch
F	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2017–2019
0.75*FMSY	75%	76%	89%	90%	90%	91%	91%	92%	92%	92%	92%	92%	92%	18,801
0.80*FMSY	74%	75%	86%	88%	89%	89%	89%	89%	89%	89%	90%	90%	90%	19,627
0.85*FMSY	72%	73%	81%	85%	86%	86%	86%	86%	86%	86%	86%	86%	86%	20,445
0.90*FMSY	69%	69%	74%	81%	81%	82%	82%	82%	82%	82%	82%	82%	82%	21,253
0.95*FMSY	64%	64%	65%	73%	75%	75%	77%	77%	77%	77%	77%	77%	77%	22,052
1.00*FMSY	59%	59%	57%	61%	66%	67%	67%	67%	63%	59%	57%	56%	57%	22,842



ICCAT ASSESSMENT FREQUENCY BY STOCK

Stock	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bluefin - West			■				■		■		■		■		■		
Bluefin - East			■				■		■		■		■		■		
Bigeye			■		■			■			■					■	
Skipjack - West									■						■		
Skipjack - East									■						■		
Yellowfin	■			■					■			■					■
Albacore - North	■							■		■				■			■
Albacore - South				■				■				■		■			■
Albacore - Med											■	■					
Swordfish - North			■				■			■				■			
Swordfish - South			■				■			■				■			
Swordfish - Med				■				■			■				■		■
White Marlin			■				■						■				
Blue Marlin							■					■					
Sailfish - West		■								■							■
Sailfish - East		■								■							■
Blue Shark					■				■							■	
Shortfin Mako - N&S					■				■				■				
Porbeagle - multiple										■							

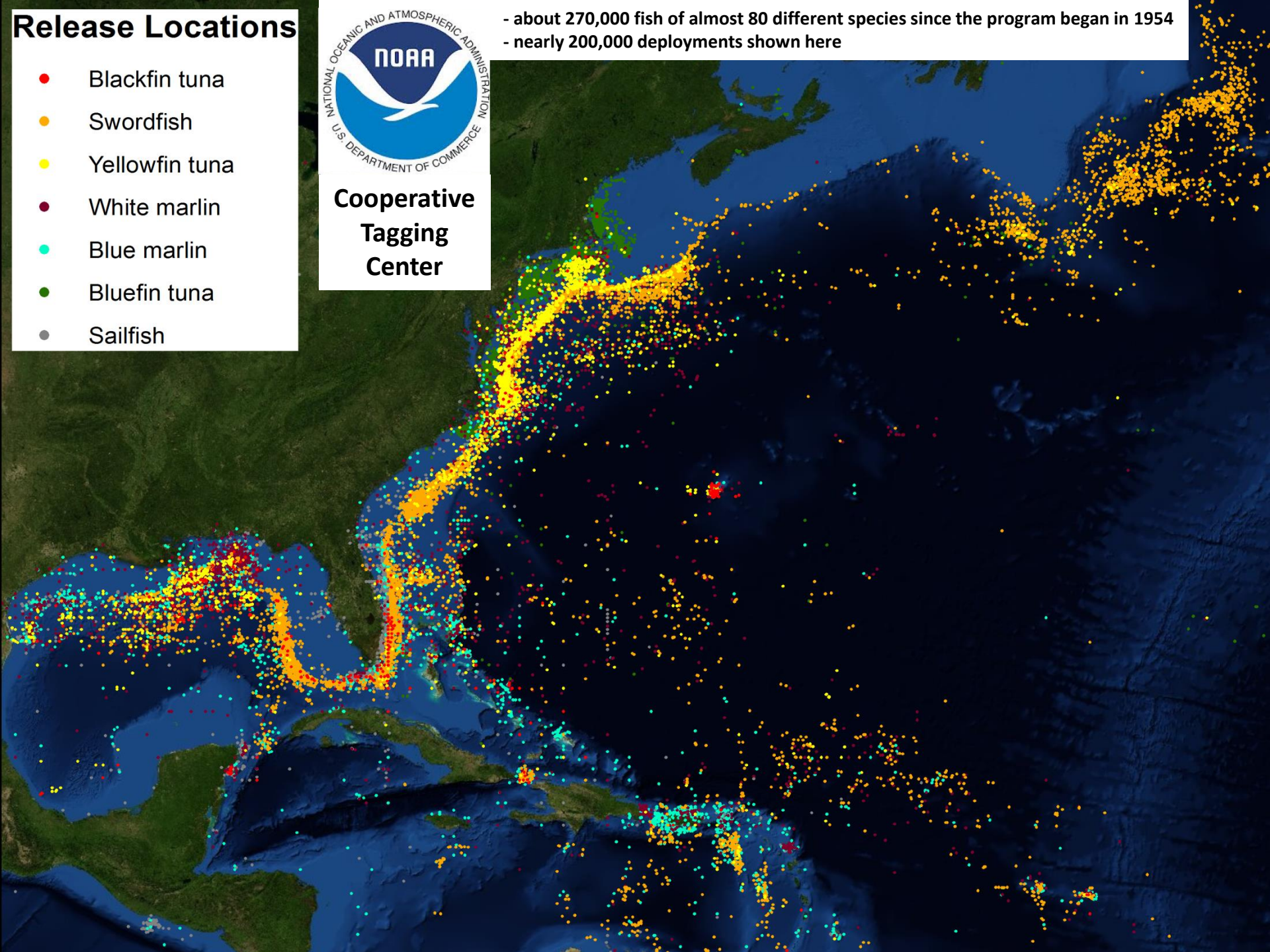
SCRS Officers

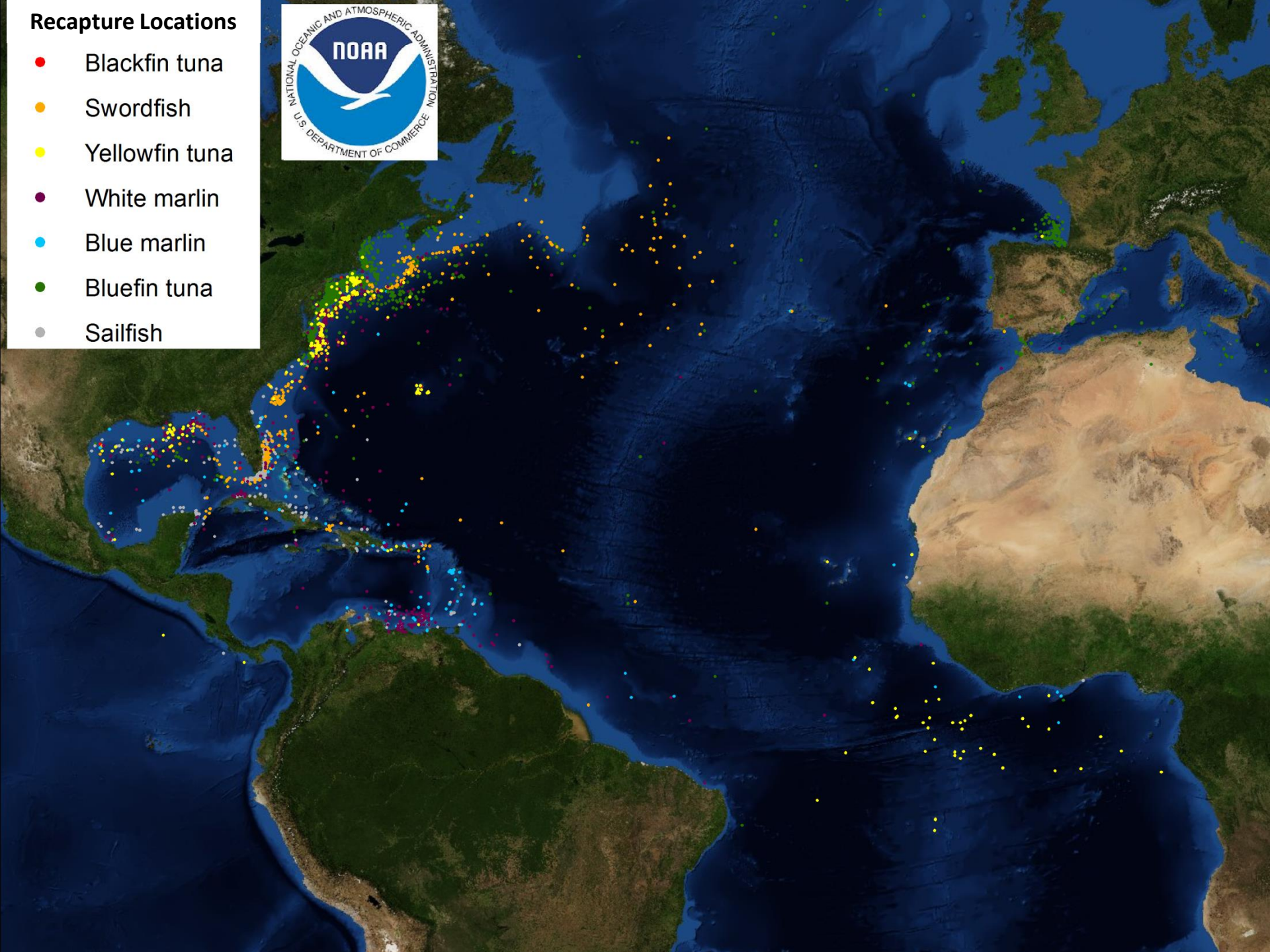
Chairman, SCRS	David Die (USA)
Sub-Committee on Ecosystems	Kotaro Yokawa (Japan) - convener/bycatch
	Alex Hanke (Canada) - Ecosystem Based Fisheries Mgmt
Sub-Committee on Statistics	Guillermo Diaz (USA)
Methods Working Group	Michael Schirripa (USA)
Tropical Tunas Coordinator	Paul Bannerman (Ghana)
Bigeye tuna	Hilario Murua (EU)
Yellowfin tuna	Shannon Calay (USA)
Skipjack	Monin Justin Amande (Côte d'Ivoire)
Atlantic Albacore:	Haritz Arrizabalaga (EU)
Mediterranean Albacore	José Mª Ortiz de Urbina (EU)
Bluefin tuna Coordinator:	Clay Porch (USA)
Eastern Atlantic Bluefin	Ana Gordoa (EU)
Western Atlantic Bluefin	Gary Melvin (Canada)
Billfishes	Freddy Arocha (Venezuela)
Swordfish Coordinator:	Rui Coelho (EU)
North Atl Swordfish	Rui Coelho (EU)
South Atl Swordfish	Humber Andrade (Brazil)
Mediterranean Swordfish	George Tserpes (EU)
Sharks	Enric Cortés (USA)
Small tunas	Nouredine Abid (Morocco)
Enhanced Billfish Research Pgm Coord:	John Hoolihan (USA)
East	Fambaye Ngom Sow (Senegal)
West	John Hoolihan (USA)

SCRS Meetings Scheduled for 2017

Date	Meeting	Location
6 – 11 Mar	Bluefin tuna data preparatory meeting	Madrid, Spain
28 - 31 Mar	Shortfin mako shark data preparatory meeting	Madrid, Spain
3 – 7 Apr	Atlantic swordfish data preparatory meeting	Madrid, Spain
24 – 28 Apr	Small Tunas species group intersessional meeting	Miami, USA
8 – 12 May	Meeting of the ICCAT Working Group on Stock Assessment Methods	Madrid, Spain
5 – 9 June	Albacore species group intersessional meeting	Madrid, Spain
12 – 16 Jun	Shortfin mako shark stock assessment session	Madrid, Spain
29 – 30 Jun	Meeting of the Standing Working Group on Dialogue between Fisheries Scientists and Managers	Madrid, Spain
3 – 7 Jul	Atlantic swordfish stock assessment session	Madrid, Spain
10 – 14 Jul	Sub-Committee on Ecosystems intersessional meeting	Madrid, Spain
20 – 28 Jul	Bluefin tuna stock assessment session	Madrid, Spain
4 – 8 Sep	Tropical tuna species group intersessional meeting	Madrid, Spain
11 – 12 Sep	3rd Meeting of the Ad Hoc Working Group on FADs	Madrid, Spain
25 – 29 Sep	SCRS Species Groups meetings (SC Statistics 25-26)	Madrid, Spain
2 – 6 Oct	Meeting of the Standing Committee on Research and Statistics (SCRS Annual Report to the Commission Adopted)	Madrid, Spain

Examples of SEFSC Highly Migratory Species Research in the Gulf of Mexico


Release Locations
Blackfin tuna
Swordfish
Yellowfin tuna
White marlin
Blue marlin
Bluefin tuna
Sailfish
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
Cooperative Tagging Center
- about 270,000 fish of almost 80 different species since the program began in 1954
- nearly 200,000 deployments shown here


Recapture Locations
Blackfin tuna
Swordfish
Yellowfin tuna
White marlin
Blue marlin
Bluefin tuna
Sailfish
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Recreational Billfish Survey

- Billfish tournaments must register and report catch and effort data to the SEFSC
- Onsite biological sampling (*e.g.* Venice, Louisiana)

Larval Surveys

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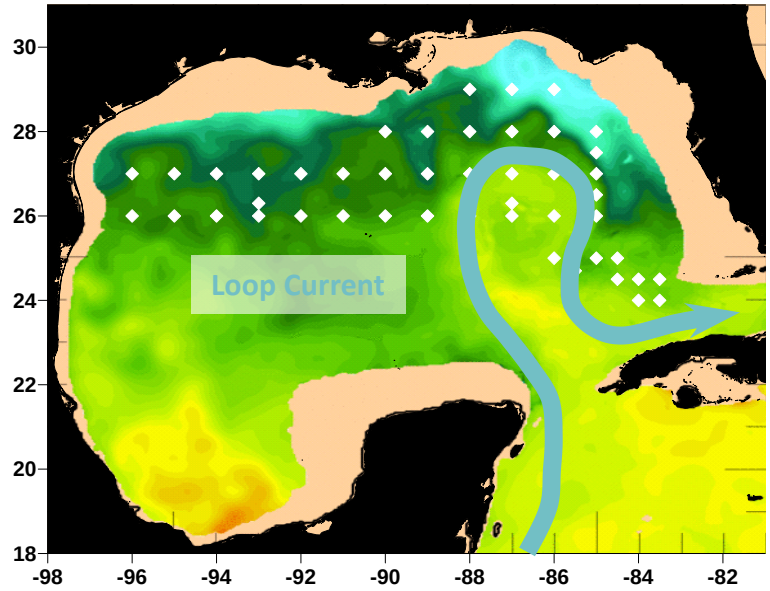
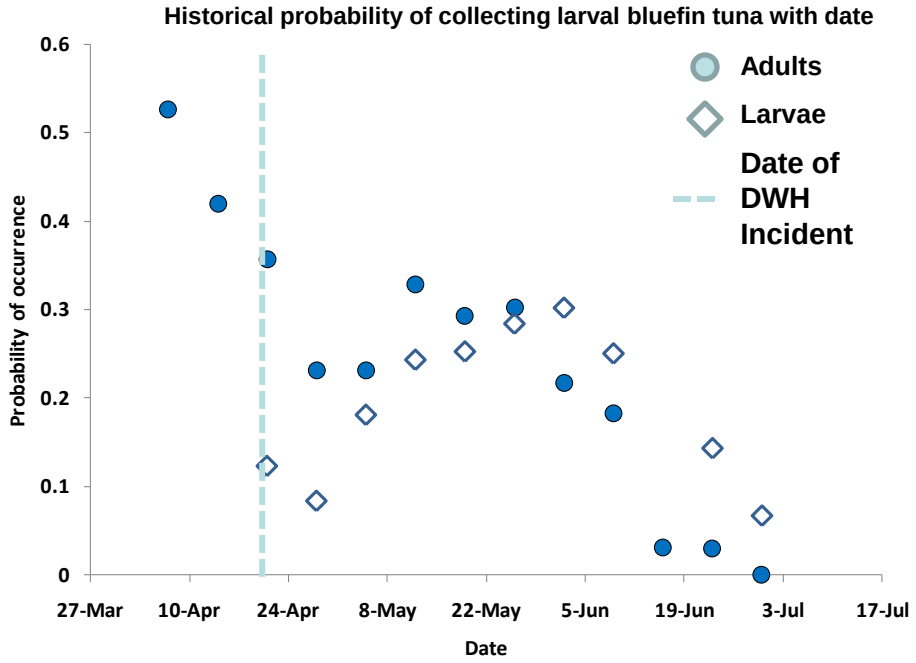
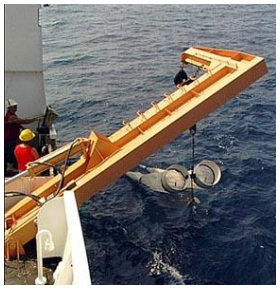
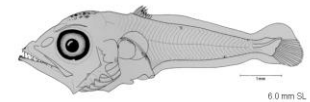
Bluefin tuna larval collection and spawning season

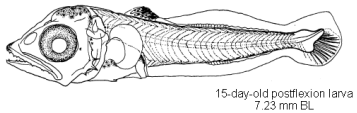




- Annual spring (April – June) plankton surveys targeting bluefin tuna larvae have been completed across the northern Gulf of Mexico since 1977

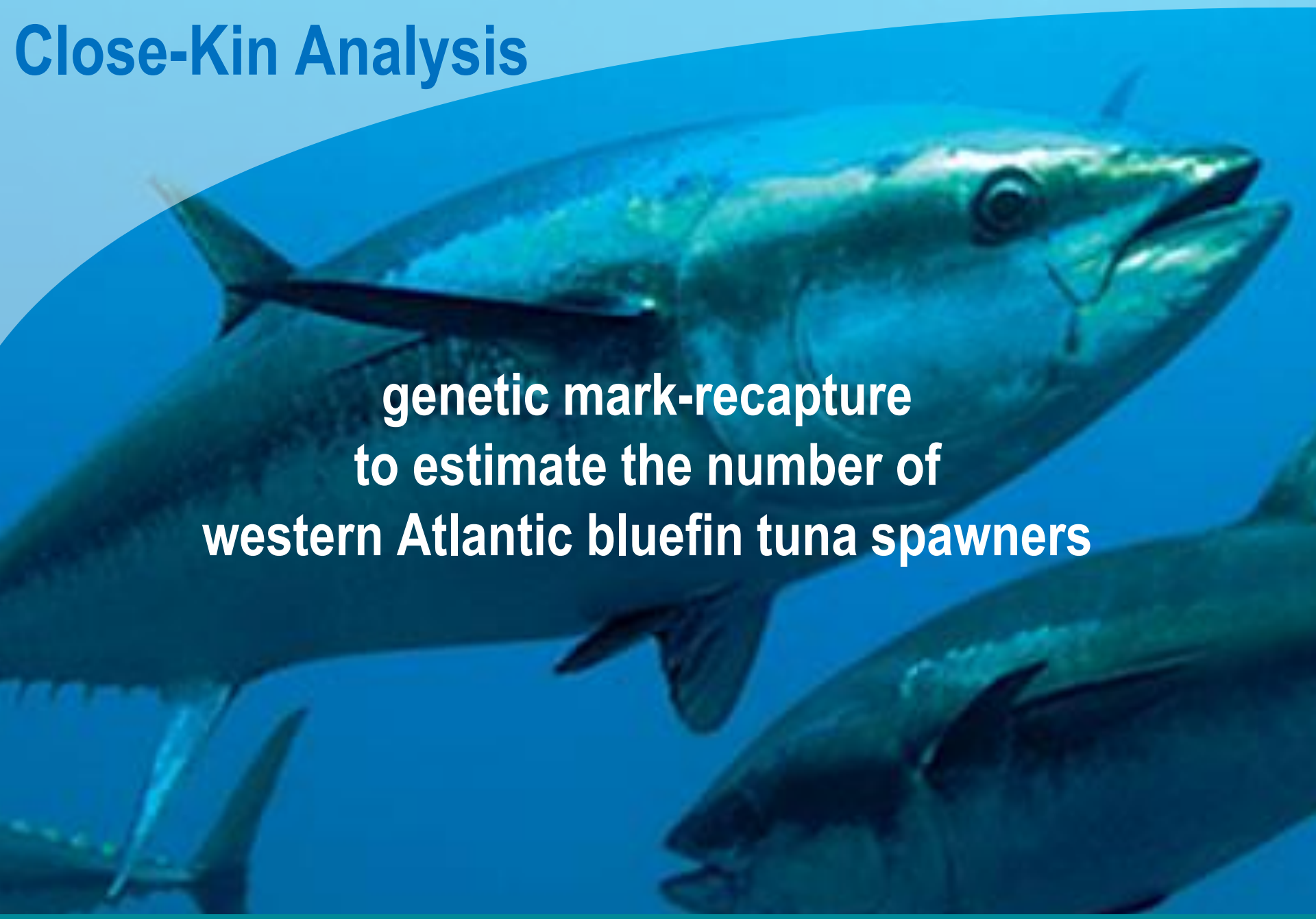






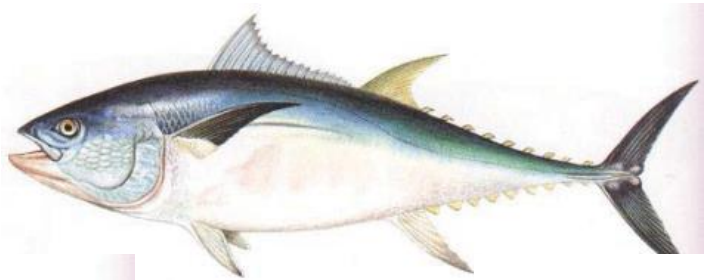
- Bluefin tuna larval abundances typically increase from mid April, and peak at the end of May
- Adult bluefin tuna are caught on longline gear from November-December onwards, and are generally rare by mid-June
- Larval data from the surveys are used to develop relative abundance indices of the western Atlantic bluefin tuna spawning stock for the assessments.

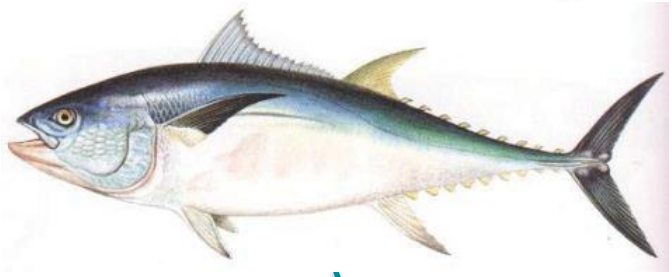
Close-Kin Analysis

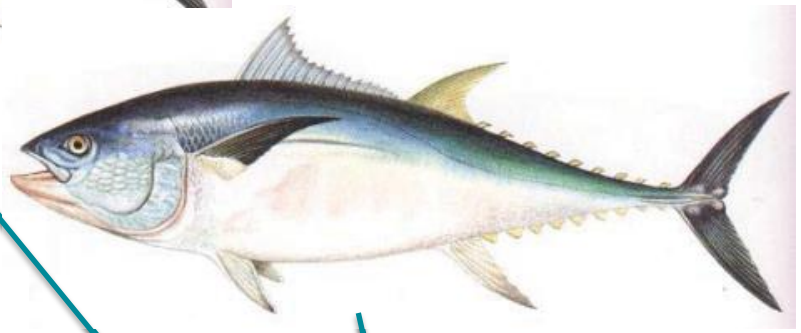


genetic mark-recapture
to estimate the number of
western Atlantic bluefin tuna spawners

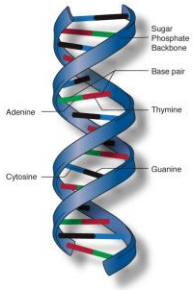
As a result of recent advances in DNA analysis, we can now uniquely identify individuals:

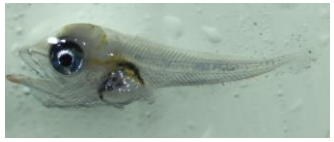


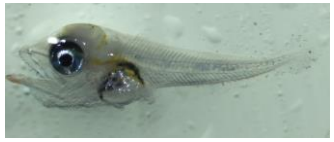


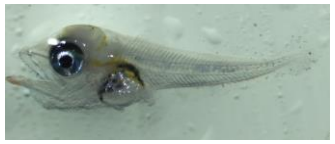


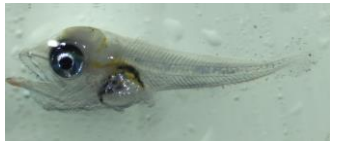
And their progeny







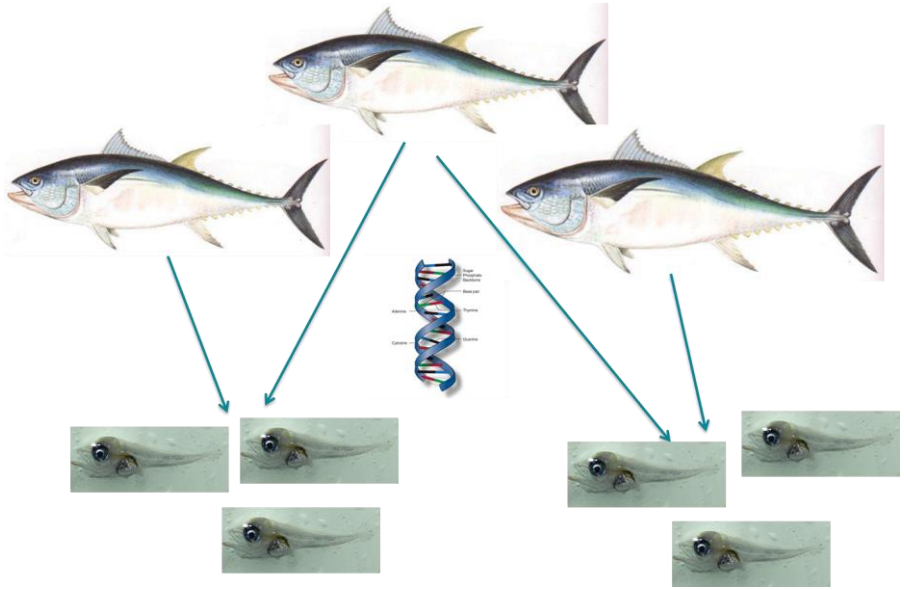




Larval pictures from Katherine Dale, NMFS

Close-Kin Analysis

By counting number of parent-offspring pairs, we can estimate number of parents

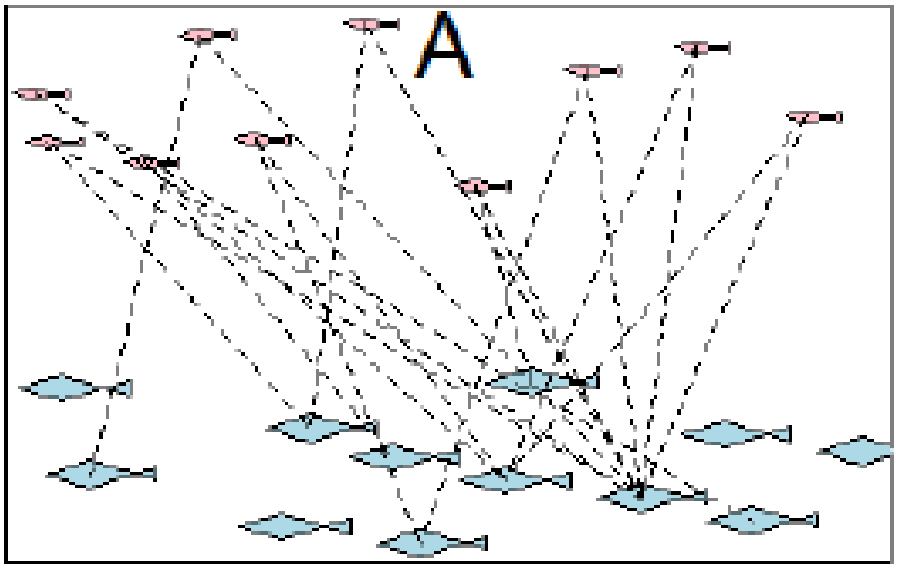


Similar to a mark-recapture experiment

Successfully applied to

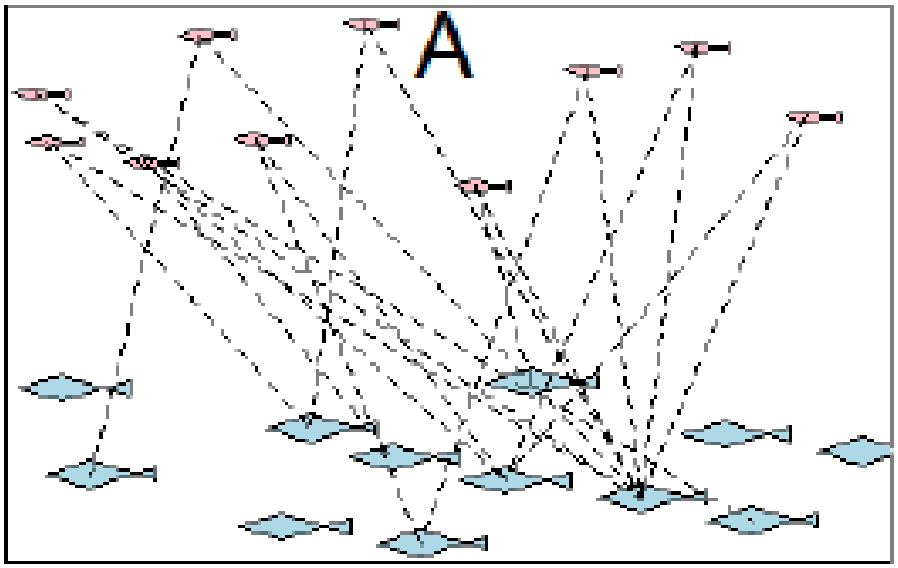
- Minke whales
- Southern Bluefin tuna

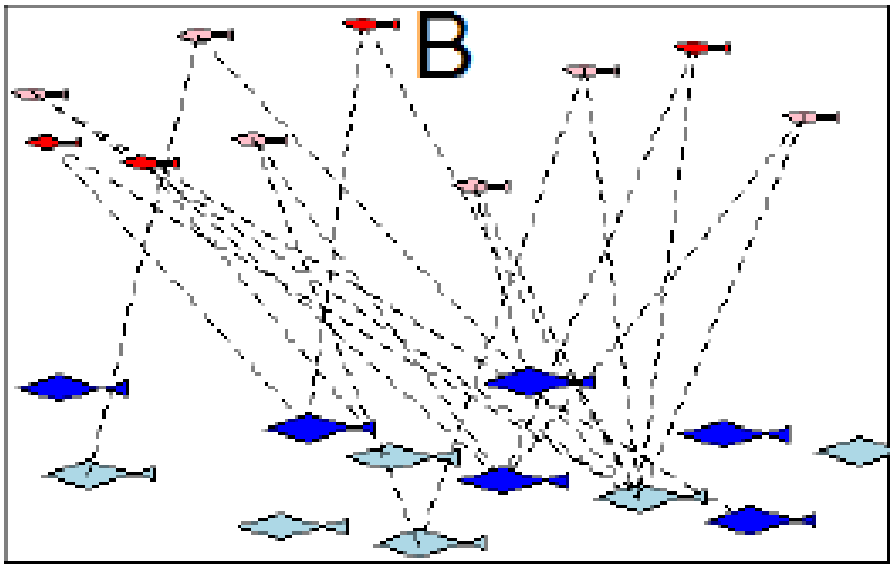
Close-Kin Analysis (Bravington et al. 2013)



A. Each juvenile ‘tags’ its parent’s DNA marker

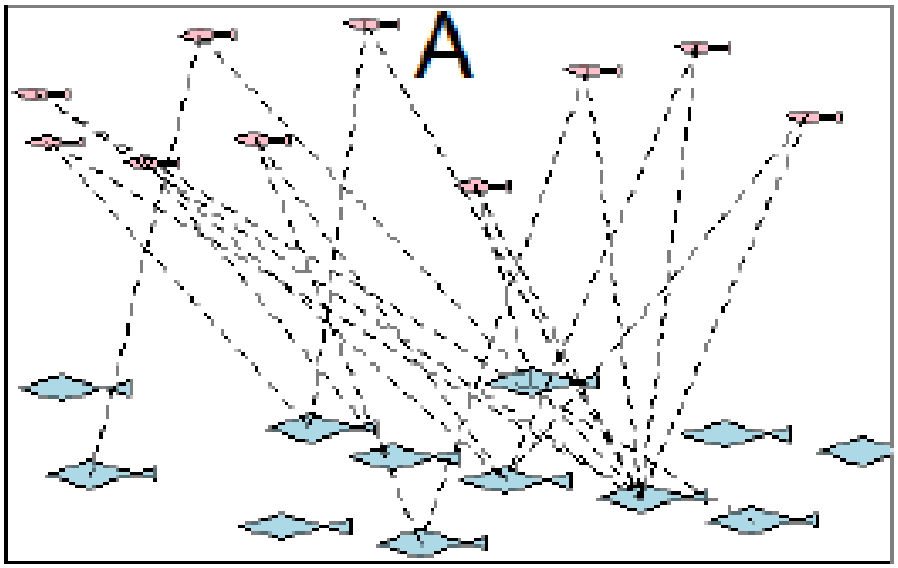
Close-Kin Analysis (Bravington et al. 2013)

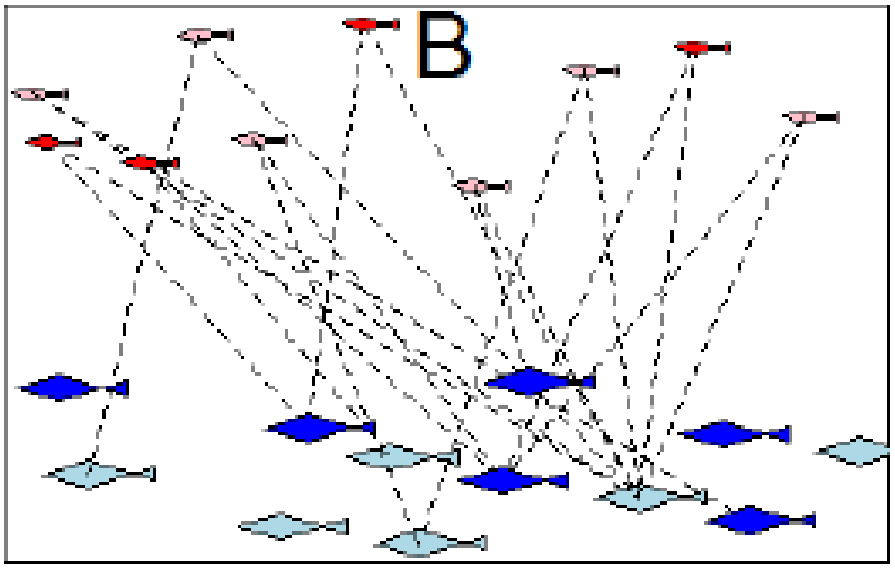




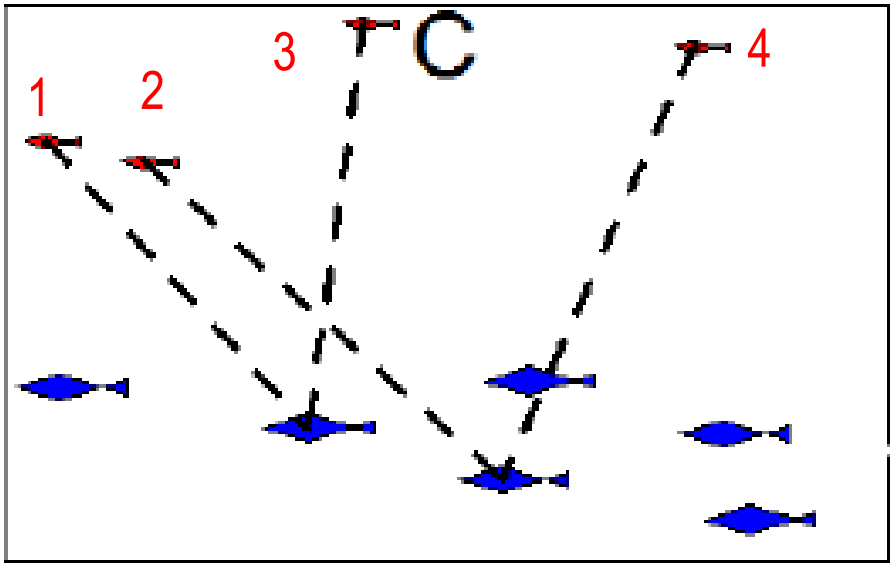
B. Sample some fraction of adults and juveniles, obtain genotypes

Close-Kin Analysis (Bravington et al. 2013)

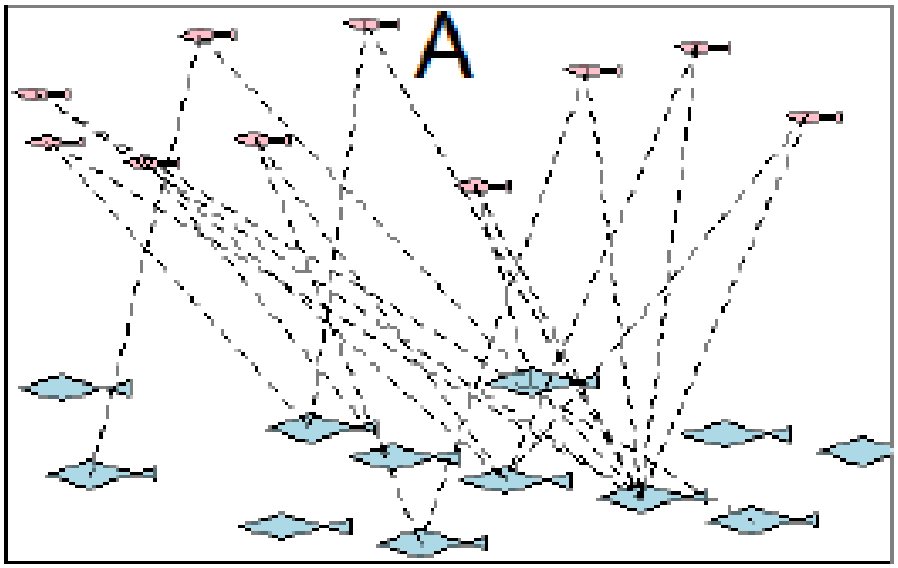


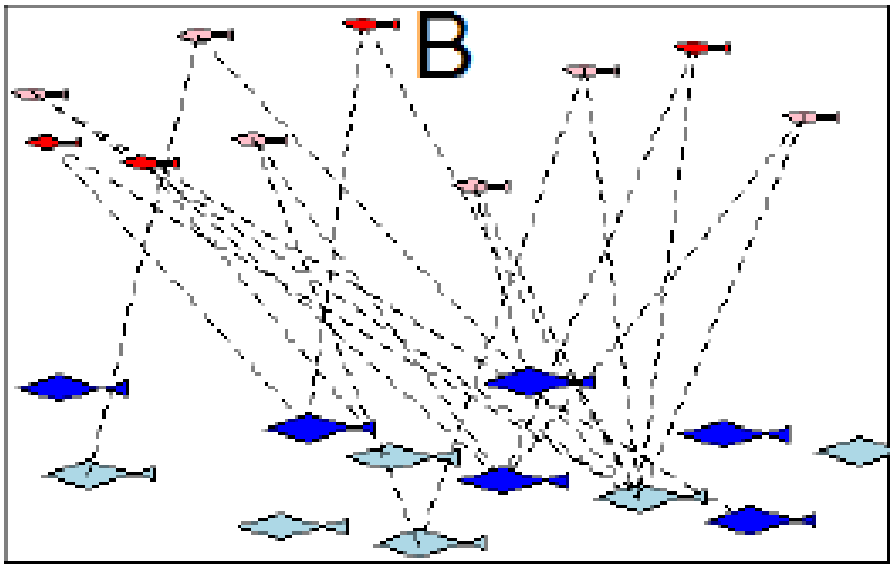


C. Genetically identify matches, i.e. number of parent/offspring pairs; here there are 4



Close-Kin Analysis (Bravington et al. 2013)





D. Estimate number of spawners:

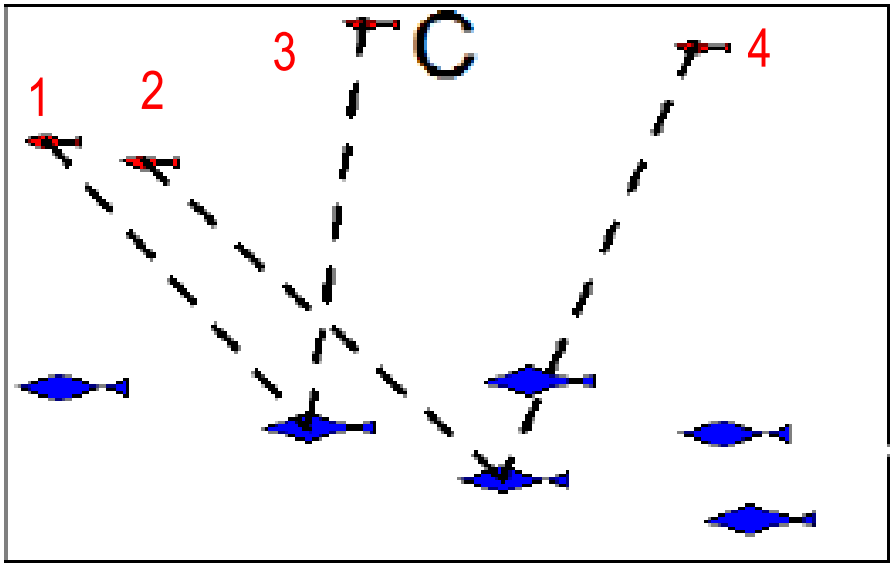
$$\widehat{N} = 2 * J * A/POP$$

4 Juveniles sampled

6 adults sampled

4 POPs

$\widehat{N} = 2 * 4 * 6/4$ =*12 spawners*



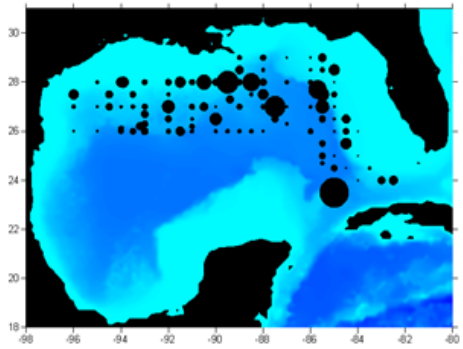
Sampling of Bluefin Tuna for Close-Kin analysis

Larvae

- larval survey ~1000-1500 per year
- the use of larvae, rather than juveniles, would avoid the need to assign stock id to the samples
- may be sufficient for CKA, if larvae are sufficiently mixed so that samples have diverse parentage
- a project is underway to evaluate the utility of samples from the Spring larval survey

GOM Spawning: Bluefin Tuna Larval Survey

Annual plankton surveys have been conducted since 1977 in the northern Gulf of Mexico during April – June. The sampling methods have included bongo net tows, neuston net tows, and CTD casts for environmental data.



Adults

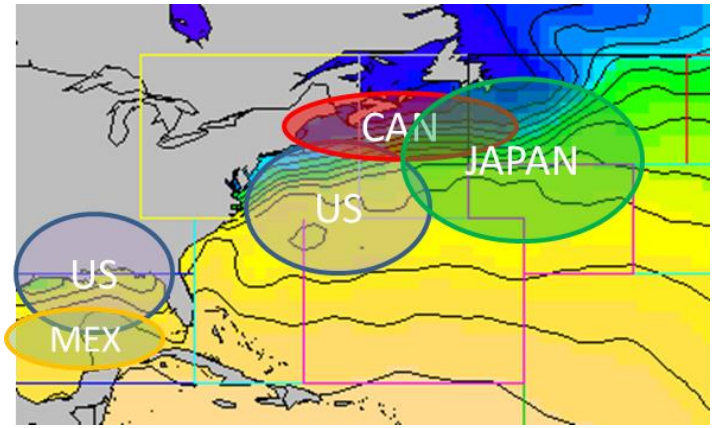
- 1500-2100 adult samples will require sampling of the US, Canadian, Japanese or Mexican fisheries.
- Some Eastern origin so may need ~2100 fish (assuming max. of 40% Eastern origin)
- Total annual catch ~7000 spawners (age 8+ fish) requires tiny tissue sample (~1 mg, pencil eraser size) from ~30% of catch
- If study was extended to multiple years annual totals would be much less

Some additional ongoing bluefin tuna research:

Joint US-Japan-Canada-Mexico longline CPUE indices

Overlap in CPUE across Northwest Atlantic

Scientists from all four countries are conducting joint analyses of data



Young of the year (YOY) sampling/survey in Florida Straits

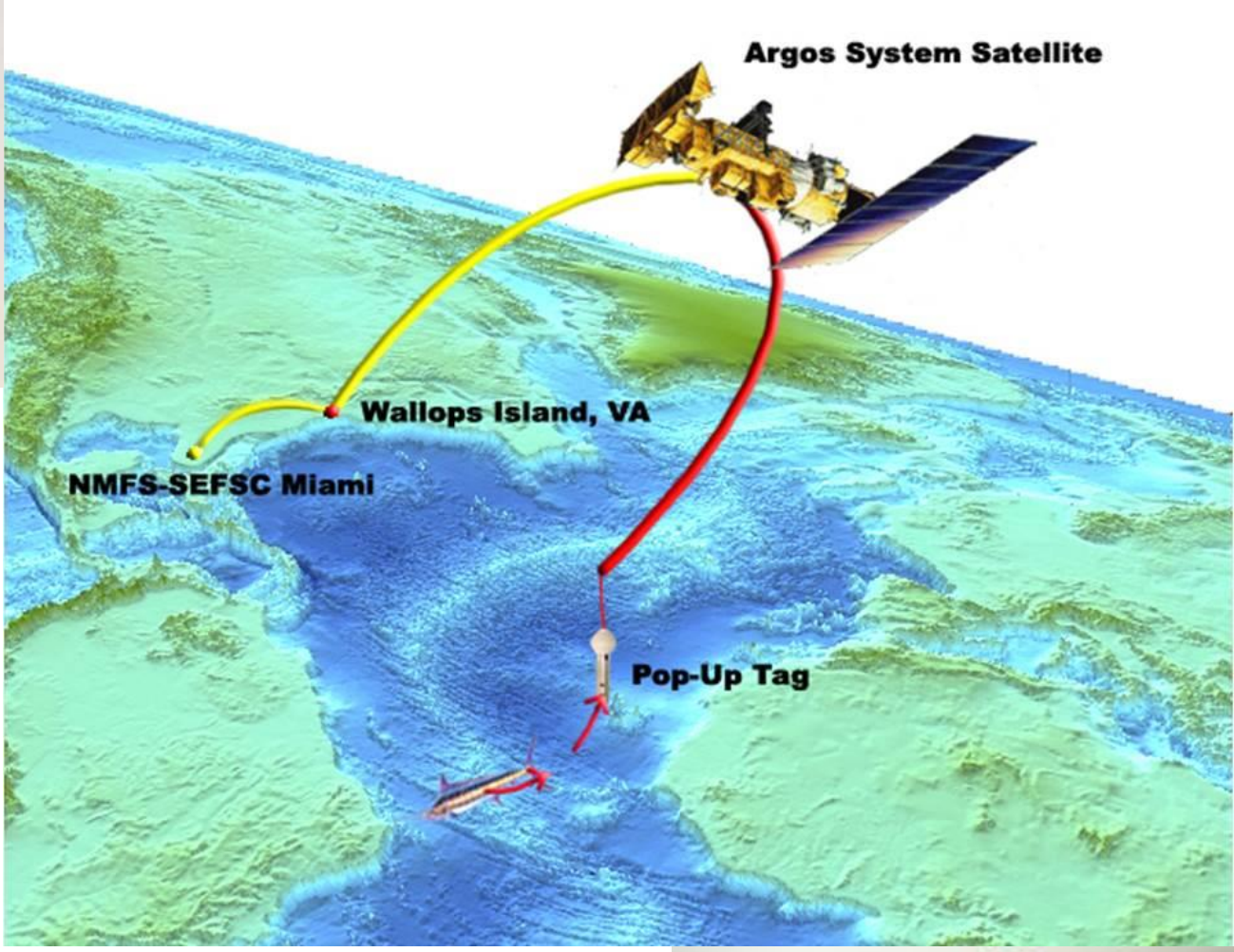
potential for YOY index or to obtain key biological samples

No YOY have been caught in 2015-2016,

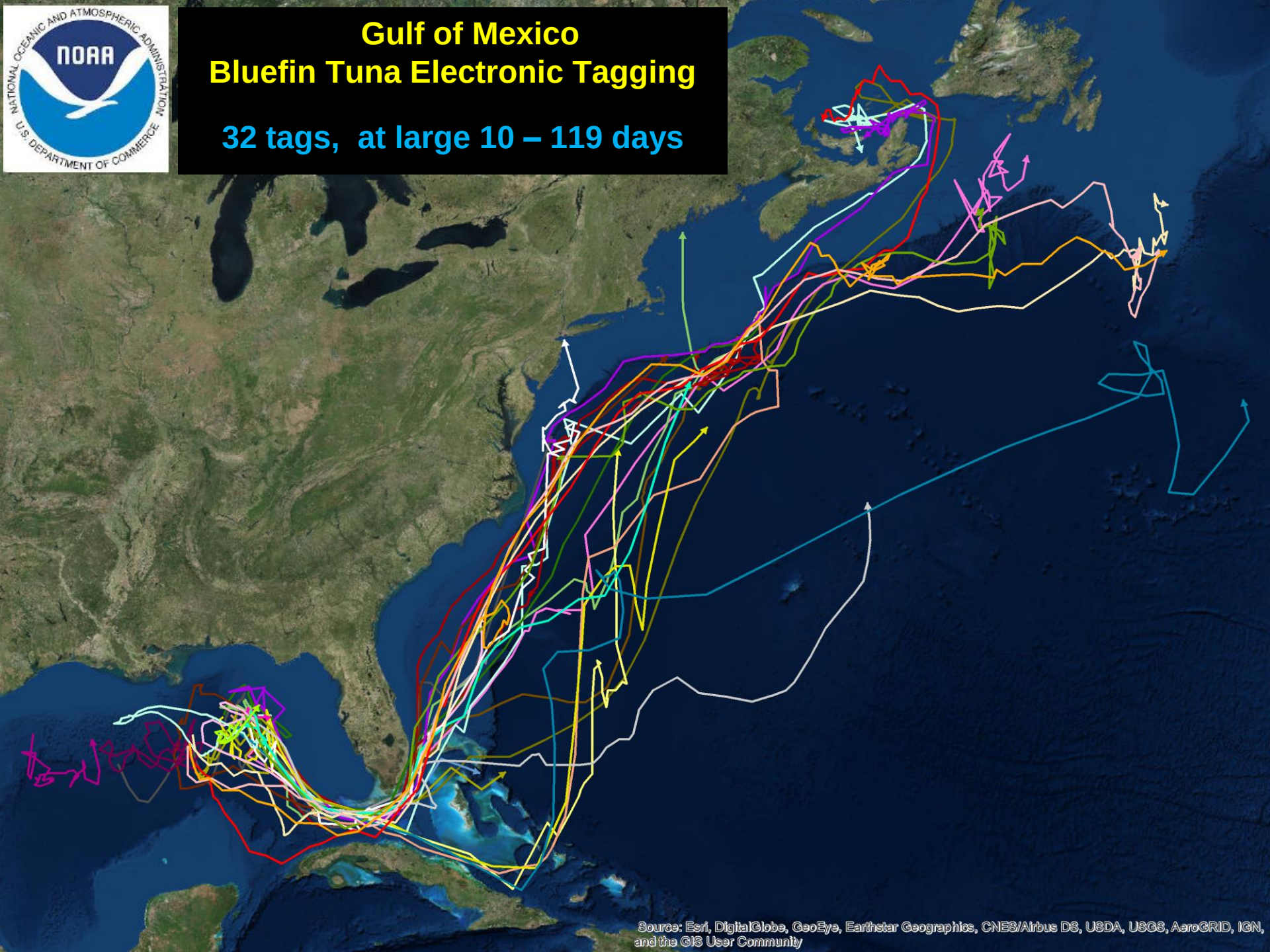
There have been reports of sightings by non-participating fishermen

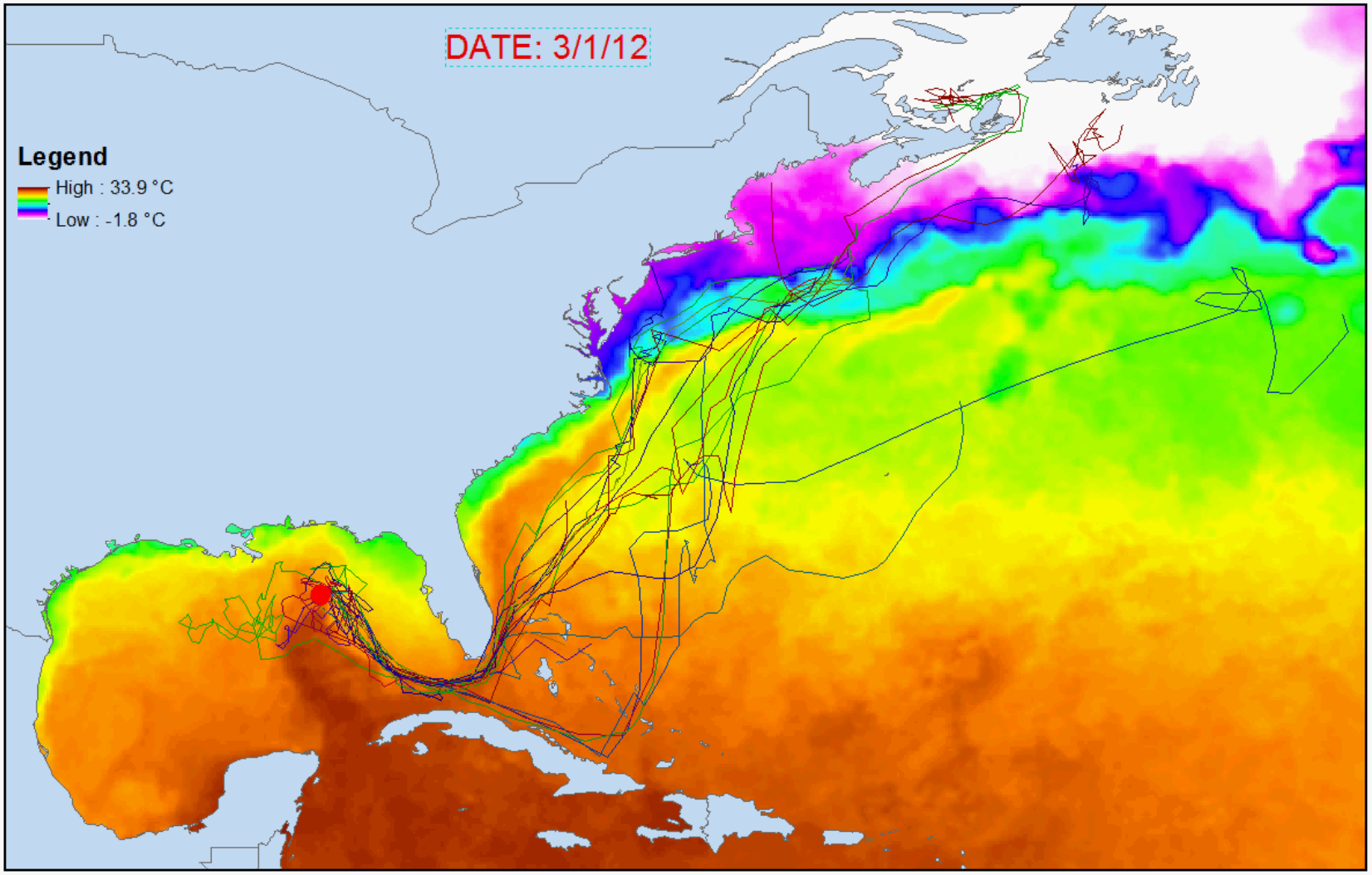
Bluefin 34-43 gillrakers

Blackfin 19-25 gillrakers



Pop-up Satellite Archival Tags

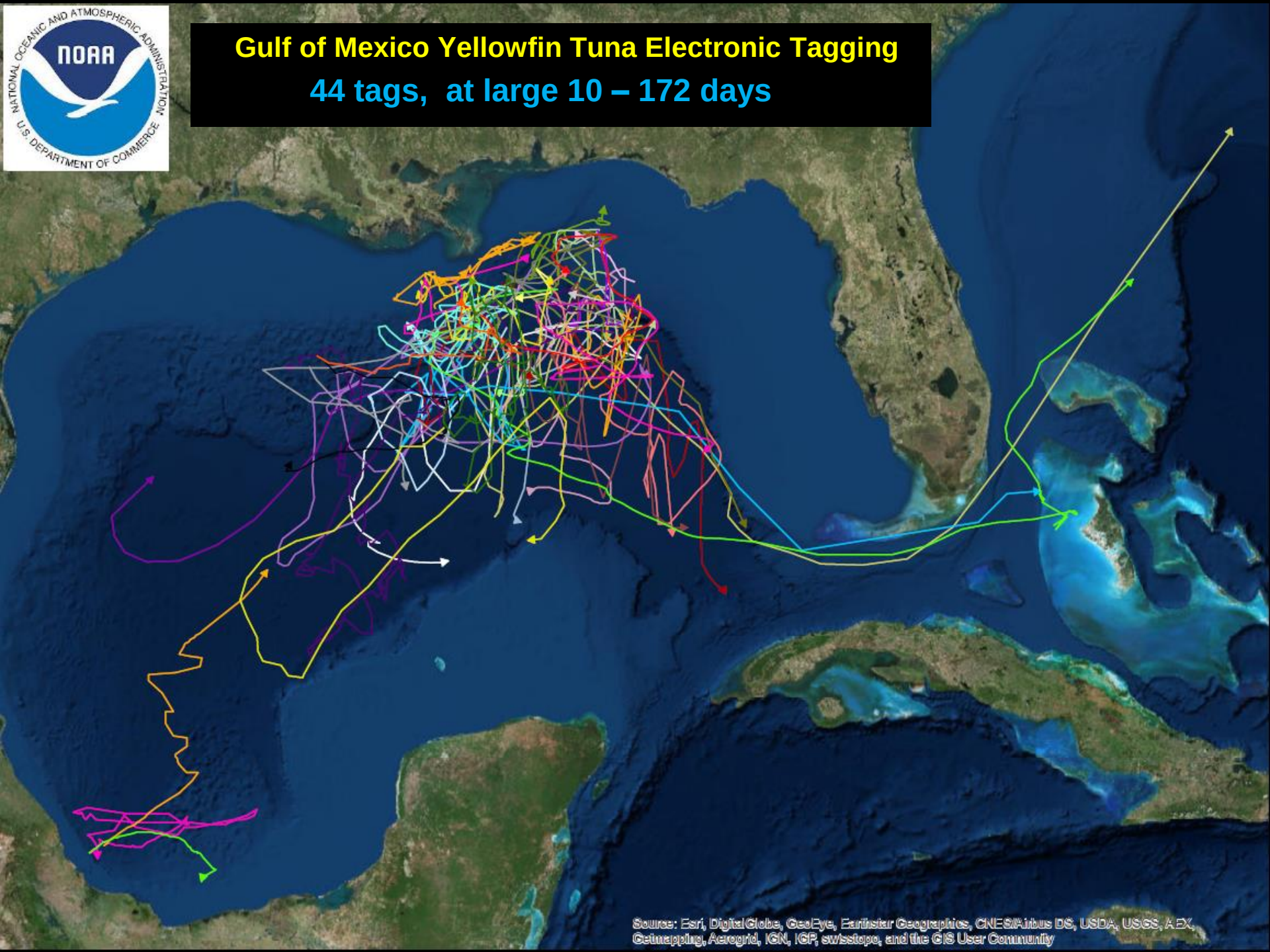

Gulf of Mexico
Bluefin Tuna Electronic Tagging
32 tags, at large 10 – 119 days
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

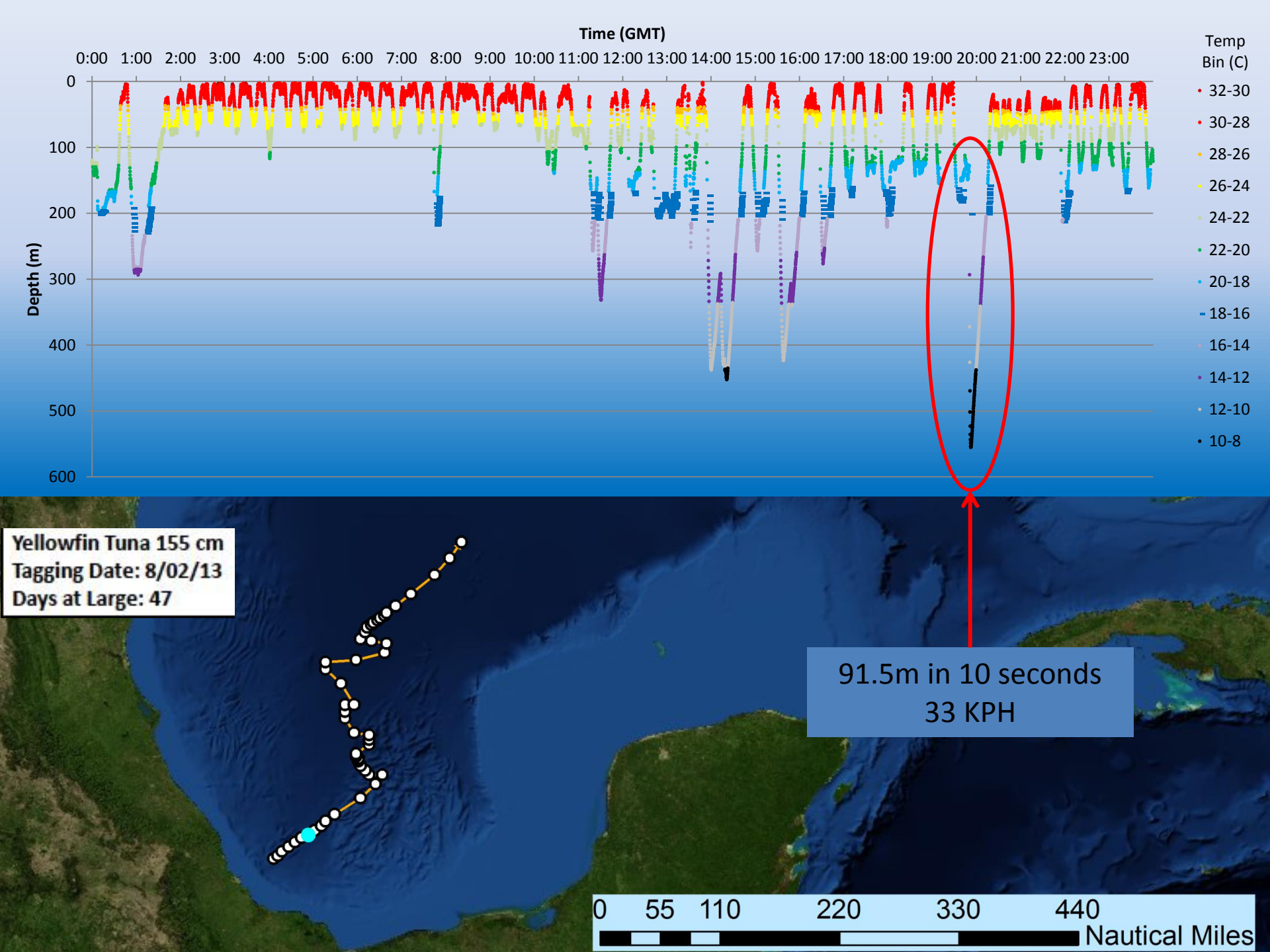

DATE: 3/1/12
Legend
High : 33.9 °C
Low : -1.8 °C

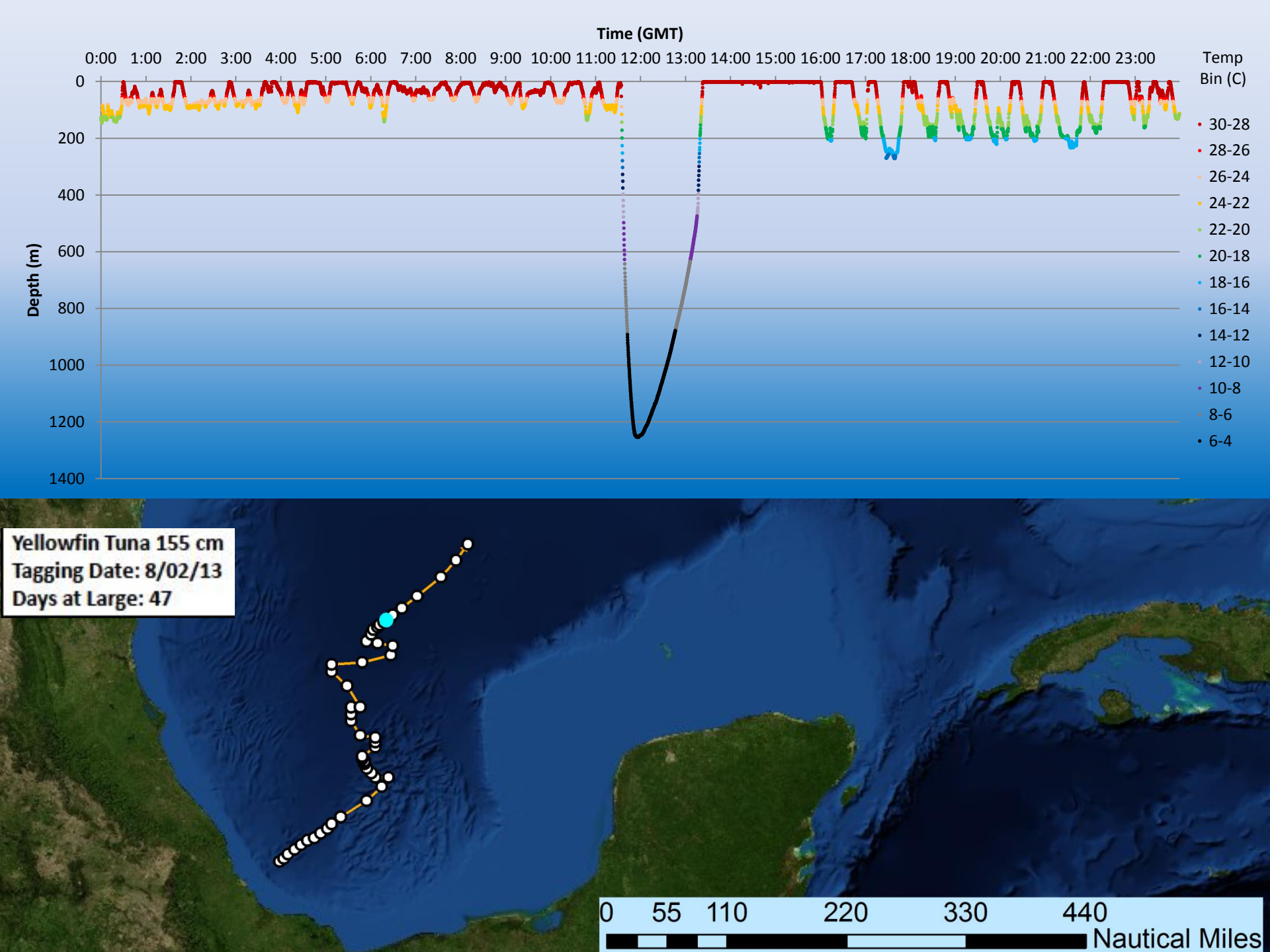
Yellowfin Tuna

Gulf of Mexico Yellowfin Tuna Electronic Tagging

44 tags, at large 10 – 172 days

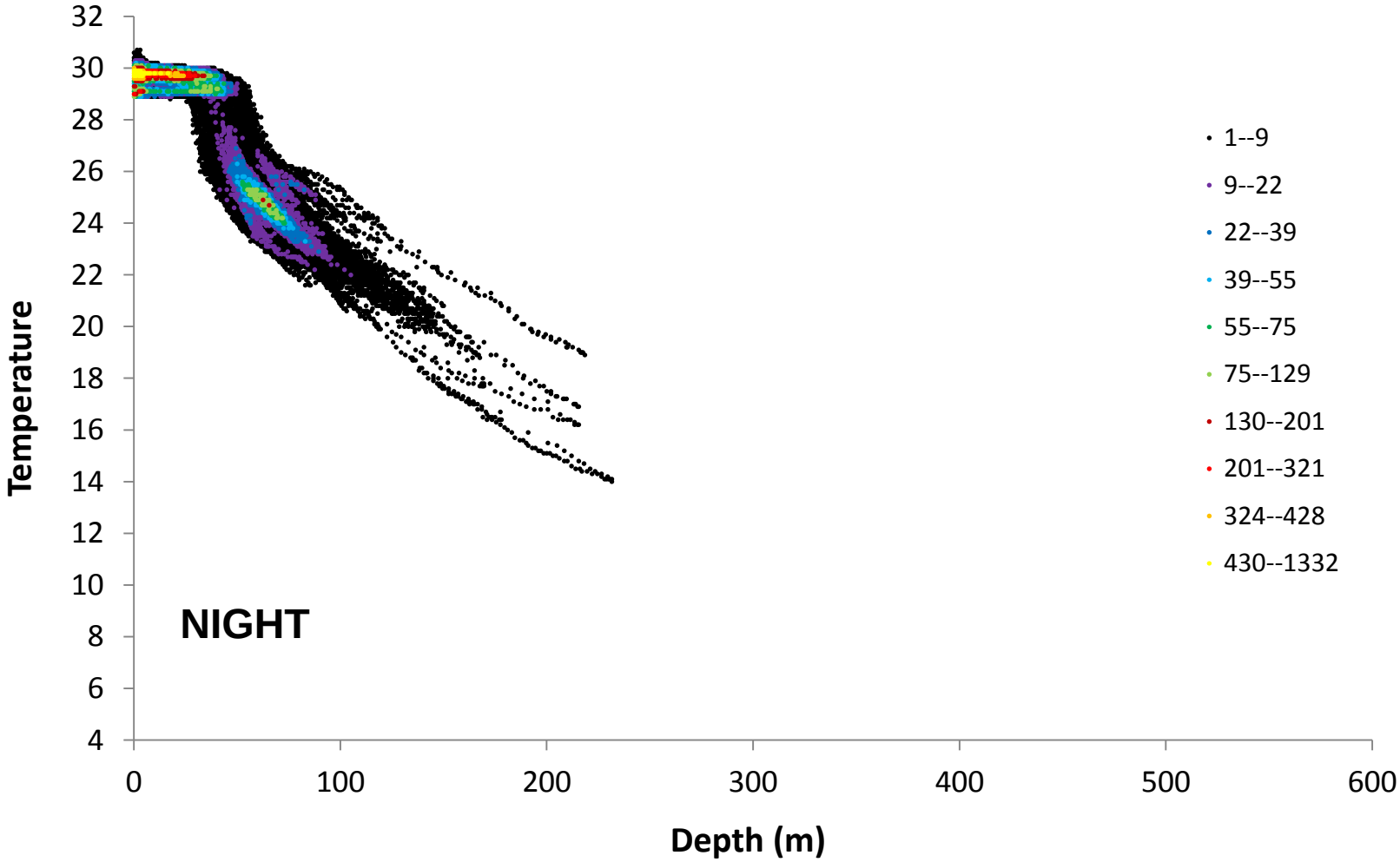



Time (GMT)
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Depth (m)
0
100
200
300
400
500
600
Temp Bin (C)
32-30
30-28
28-26
26-24
24-22
22-20
20-18
18-16
16-14
14-12
12-10
10-8
Yellowfin Tuna 155 cm
Tagging Date: 8/02/13
Days at Large: 47
91.5m in 10 seconds
33 KPH
0 55 110 220 330 440
Nautical Miles


Time (GMT)
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Depth (m)
0
200
400
600
800
1000
1200
1400
Temp Bin (C)
30-28
28-26
26-24
24-22
22-20
20-18
18-16
16-14
14-12
12-10
10-8
8-6
6-4
Yellowfin Tuna 155 cm
Tagging Date: 8/02/13
Days at Large: 47
0 55 110 220 330 440
Nautical Miles

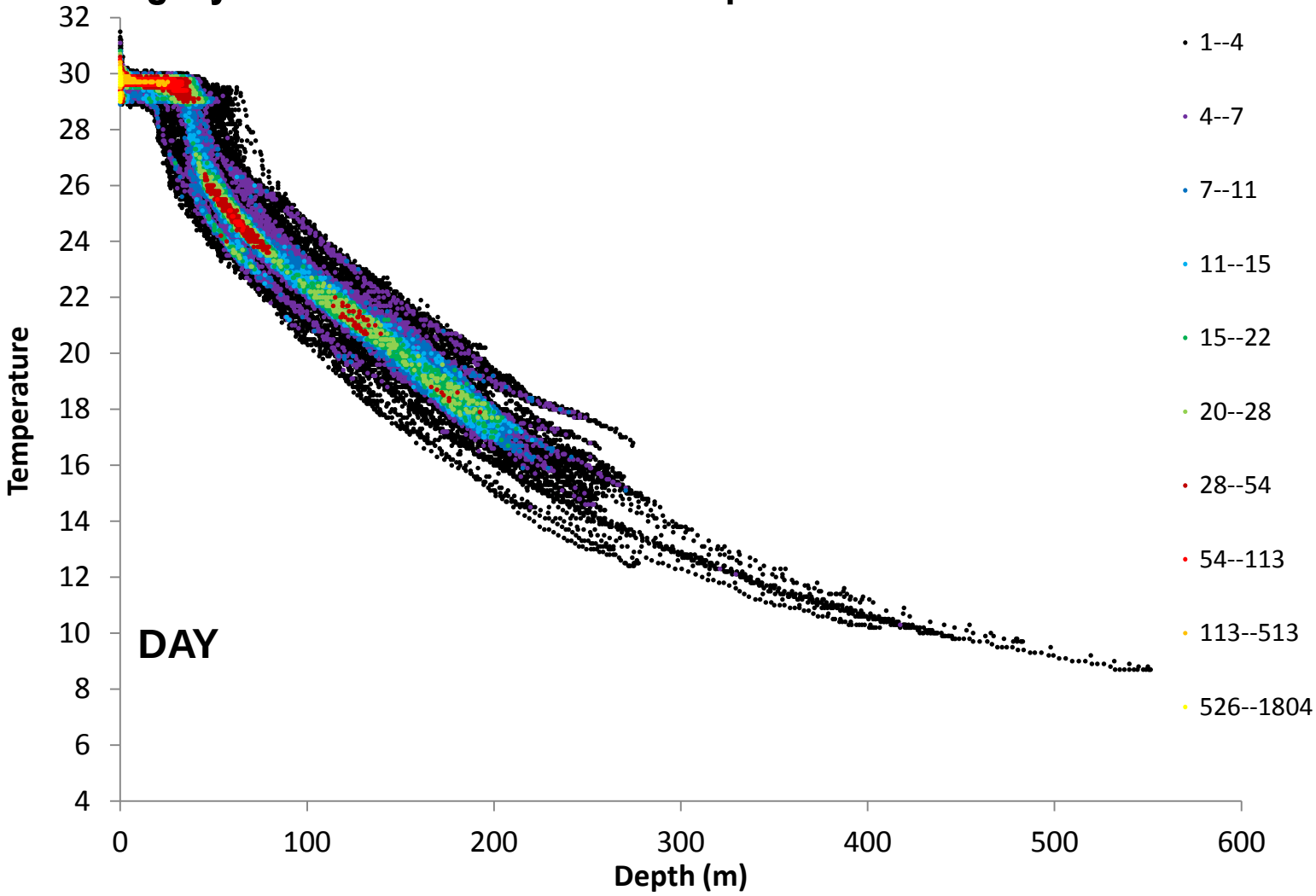
Example of data available from recovered tag:

Density plot of depth-temperature combinations (recorded every 10 seconds) for a single yellowfin tuna. Each color represents 10% of the total.



Example of data available from recovered tag:

Density plot of depth-temperature combinations (recorded every 10 seconds) for a single yellowfin tuna. Each color represents 10% of the total.




Gulf of Mexico – Mexican waters
Blue Marlin Electronic Tagging
3 tags, at large 9 – 180 days
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community