Determining the Seasonality of Oceanic eDNA Source Waters

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Outline

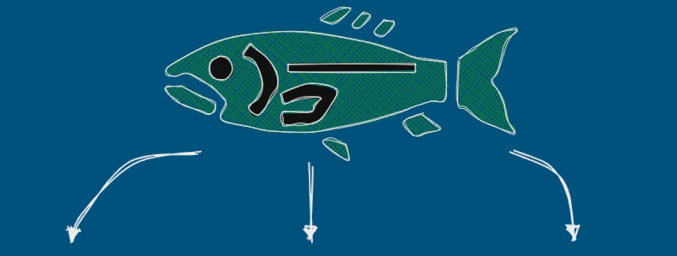
1. eDNA Background, Methods
2. 10 Year Averages
3. Inter-Annual Variability
    a. Offshore
    b. Inshore
4. Intra-Month Variability
5. Conclusions

What is eDNA?

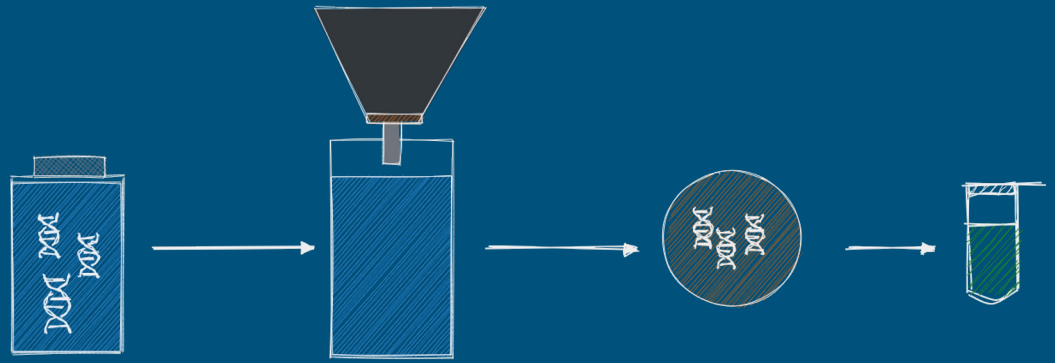
DNA is shed as cellular or extracellular material into the surrounding water

collect & filter water from aquatic systems

extract DNA from filters



eDNA degrades rapidly *in situ* ($t_{0.5}$ ~ 1d)



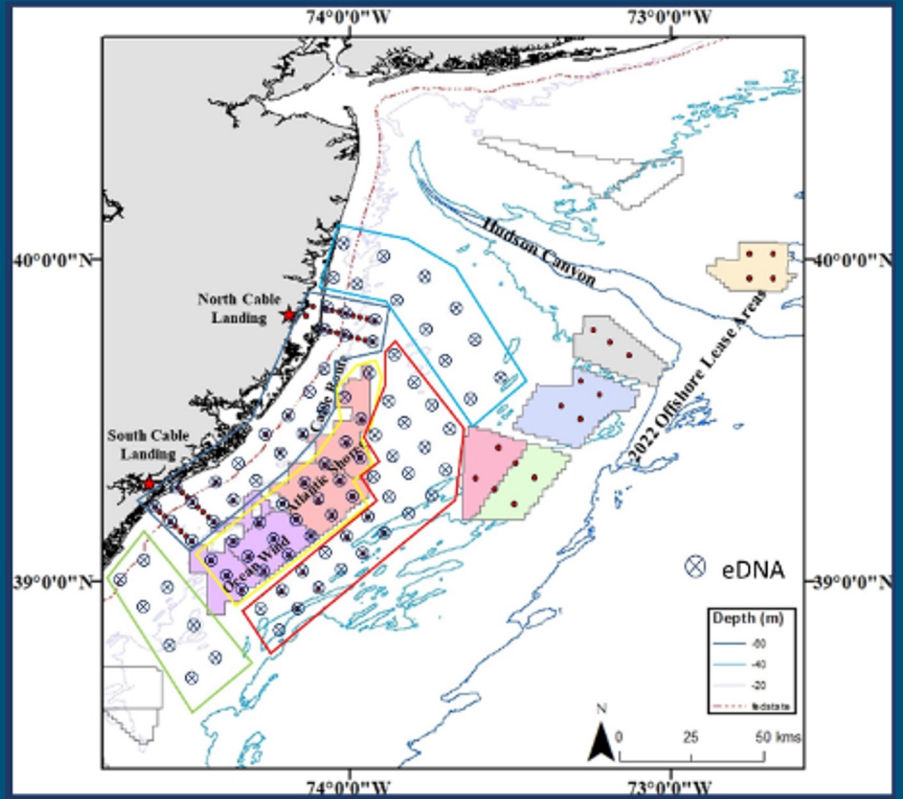
Environmental DNA = DNA isolated from an environmental sample

Motivation and Background

Oceanic eDNA is can be used for fish species assessments and for characterizing marine communities.

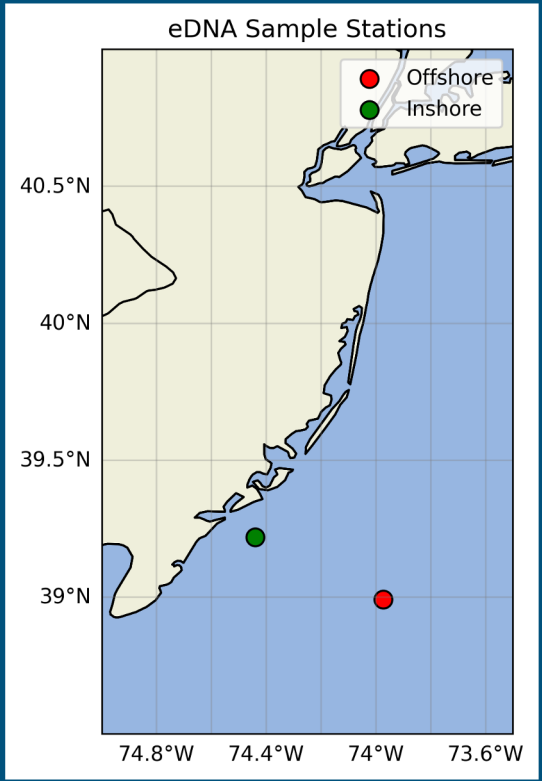
eDNA sampling can be used in offshore wind development areas to understand species in the area and contribute to regional datasets to support the Research and Monitoring Initiative (RMI)

But… we need to know where it comes from (direction and distances) and how it varies over time (seasonal differences)



eDNA PI's – Adolf, Dunton and O'Leary Acoustic telemetry PI's – Dunton and Adolf
Project managers: Colleen Brust (DEP-MRA) and Reneé Reilly (DEP-DSR)

Methods



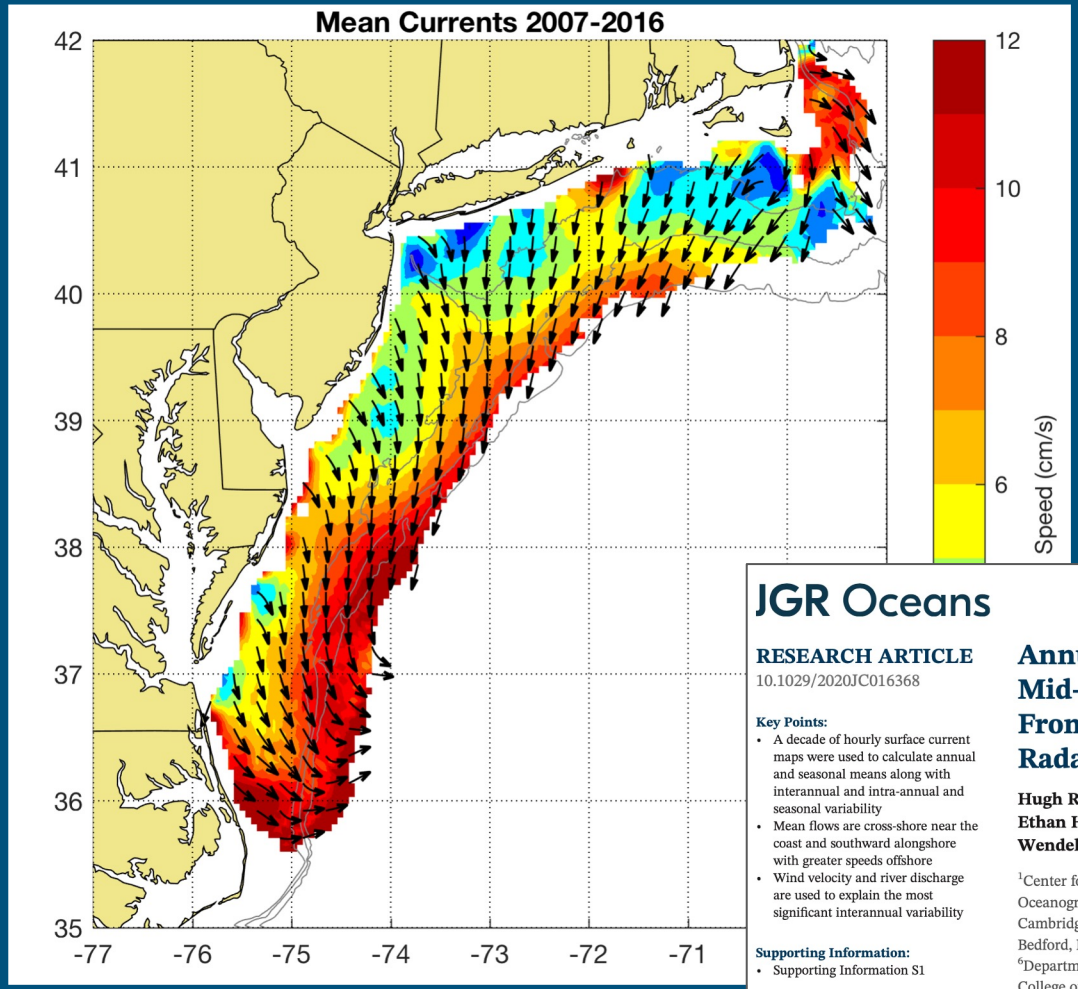
10 Year HF Radar Data Set

2 Sites of varying distances from the coast

Surface Currents OpenDrift Model Reverse Drift

Averaged absolute distance traveled of 100 simulated drifters each hour over 5 days

Test differences between years, seasons, (February, May, July, November), and days of the month



10 Years of Hourly HFR Surface Current Measurements

JGR Oceans

RESEARCH ARTICLE
10.1029/2020JC016368

Key Points:

- A decade of hourly surface current maps were used to calculate annual and seasonal means along with interannual and intra-annual and seasonal variability
- Mean flows are cross-shore near the coast and southward alongshore with greater speeds offshore
- Wind velocity and river discharge are used to explain the most significant interannual variability

Supporting Information:

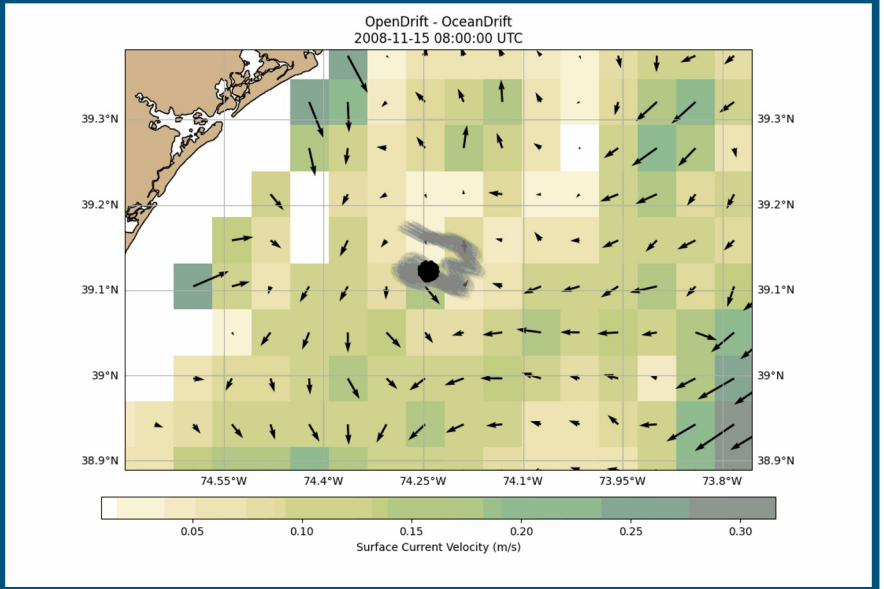
- Supporting Information S1

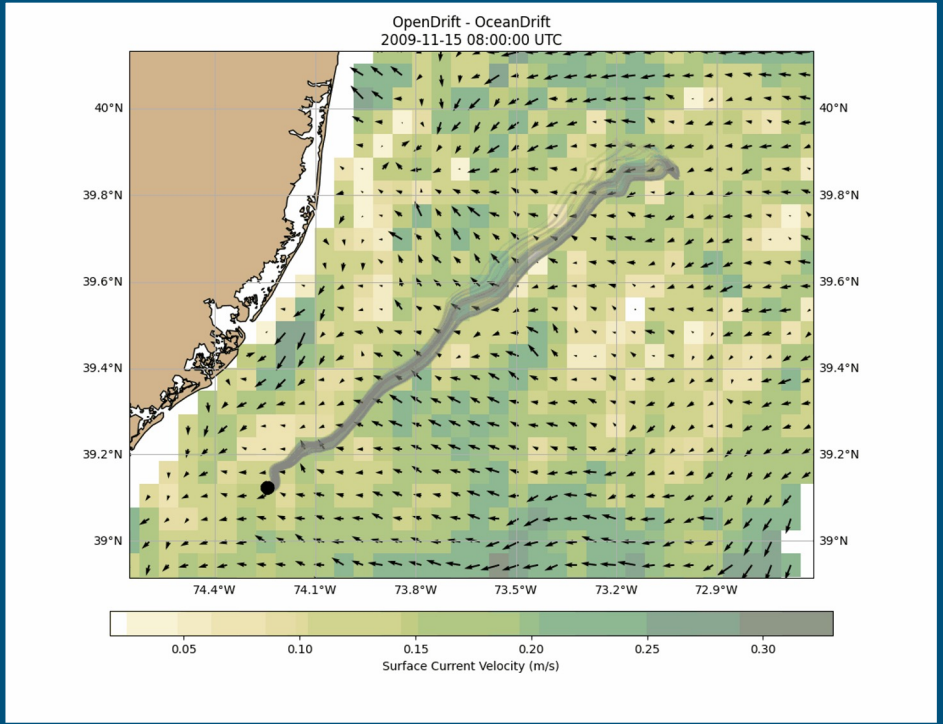
Annual and Seasonal Surface Circulation Over the Mid-Atlantic Bight Continental Shelf Derived From a Decade of High Frequency Radar Observations

Hugh Roarty[1], Scott Glenn[1], Joseph Brodie[1], Laura Nazzaro[1], Michael Smith[1], Ethan Handel[1], Josh Kohut[1], Teresa Updyke[2], Larry Atkinson[2], William Boicourt[3], Wendell Brown[4], Harvey Seim[5], Mike Muglia[6], Haixing Wang[7], and Donglai Gong[7]

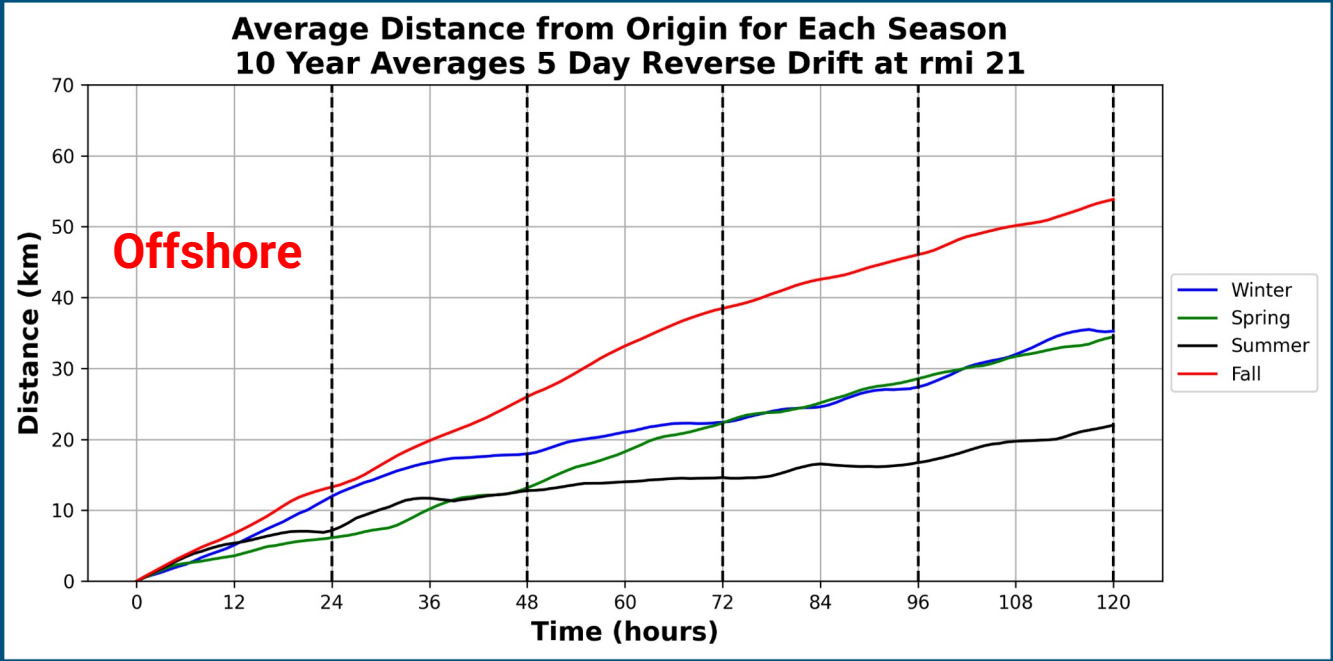
[1]Center for Ocean Observing Leadership, Rutgers University, New Brunswick, NJ, USA, [2]Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA, USA, [3]Center for Environmental Science, University of Maryland, Cambridge, MD, USA, [4]School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, MA, USA, [5]Department of Marine Sciences, University of North Carolina-Chapel Hill, Chapel Hill, NC, USA, [6]Department of Coastal Studies, East Carolina University, Wanchese, NC, USA, [7]Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, USA

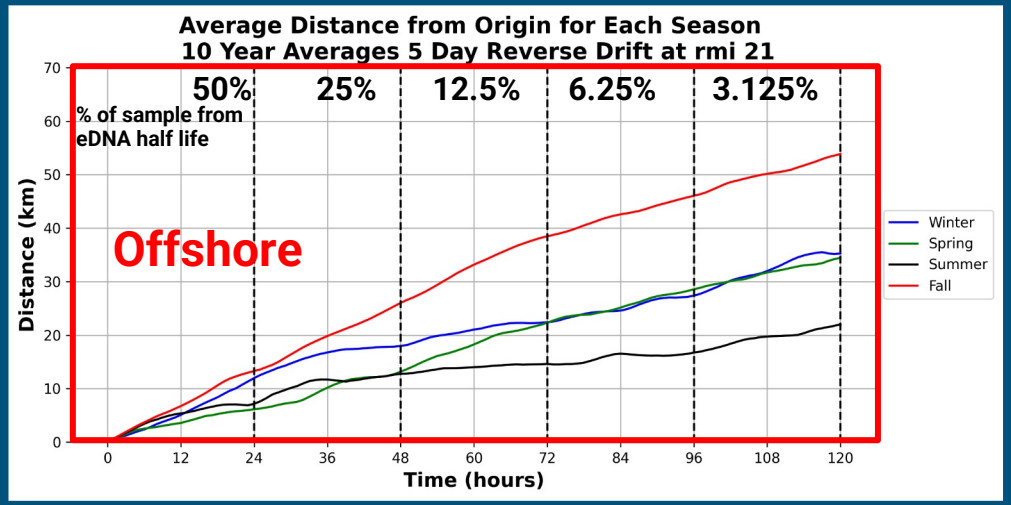
Example Releases

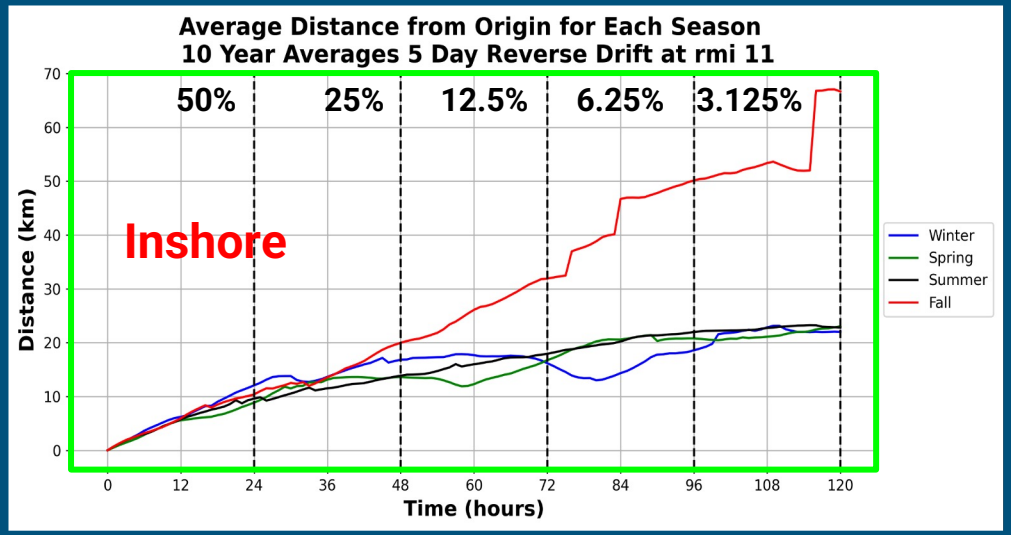




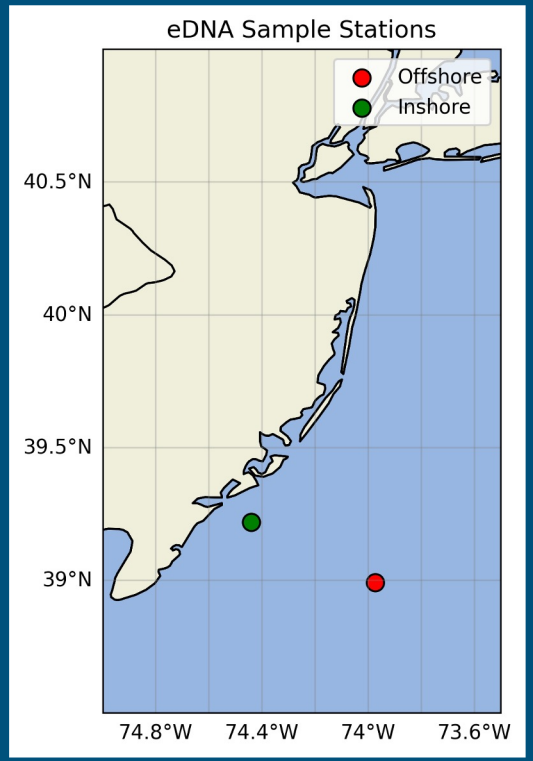
10 Year Averages



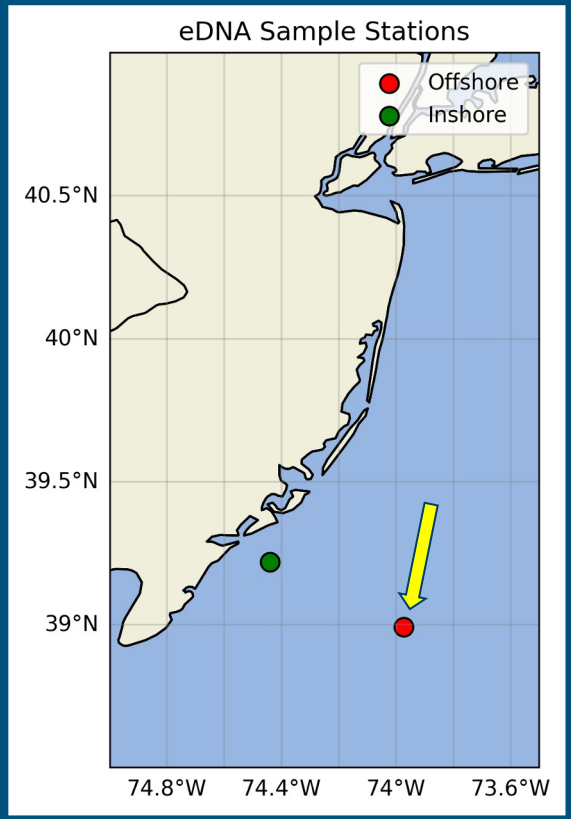


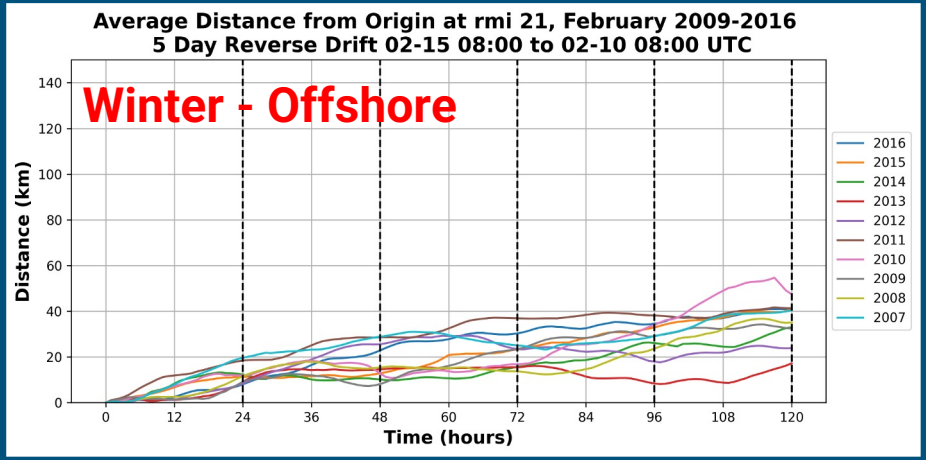


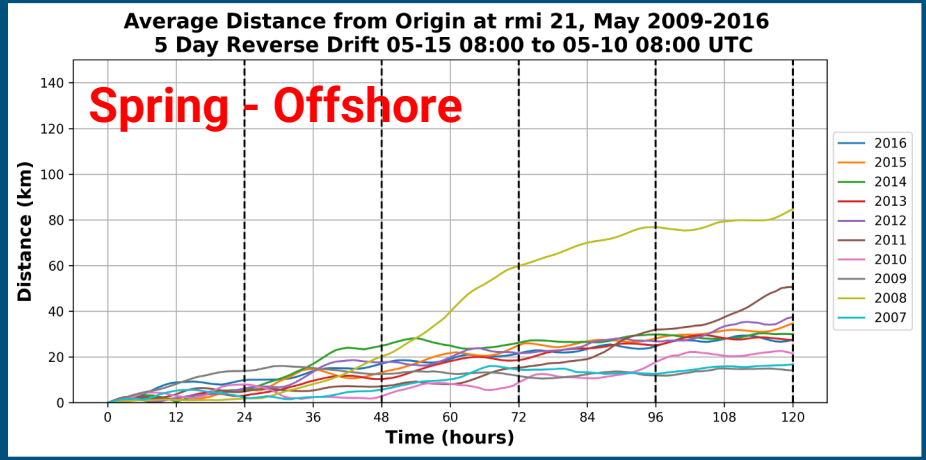
Oceanic eDNA
Half Life:
~24 hours

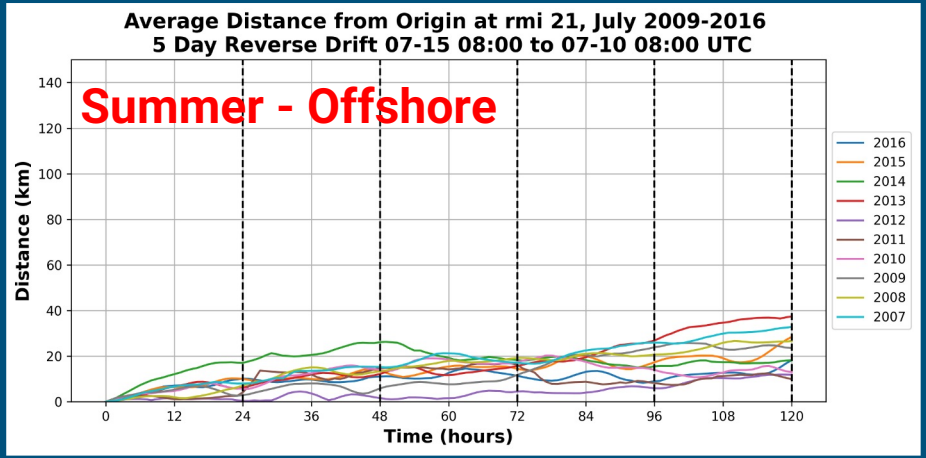


Inter-Annual Variability: Offshore




Average Distance from Origin at rmi 21, February 2009-2016
5 Day Reverse Drift 02-15 08:00 to 02-10 08:00 UTC
Winter - Offshore
Distance (km)
Time (hours)
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007


Average Distance from Origin at rmi 21, May 2009-2016
5 Day Reverse Drift 05-15 08:00 to 05-10 08:00 UTC
Spring - Offshore
Distance (km)
Time (hours)
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007


Average Distance from Origin at rmi 21, July 2009-2016
5 Day Reverse Drift 07-15 08:00 to 07-10 08:00 UTC
Summer - Offshore
Distance (km)
Time (hours)
2016
2015
2014
2013
2012
2011
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2009
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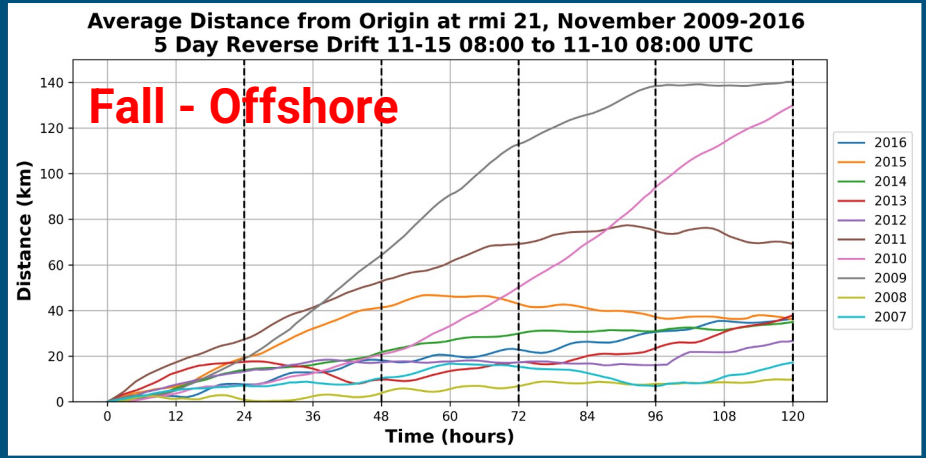
Average Distance from Origin at rmi 21, November 2009-2016
5 Day Reverse Drift 11-15 08:00 to 11-10 08:00 UTC
Fall - Offshore
Distance (km)
Time (hours)
2016
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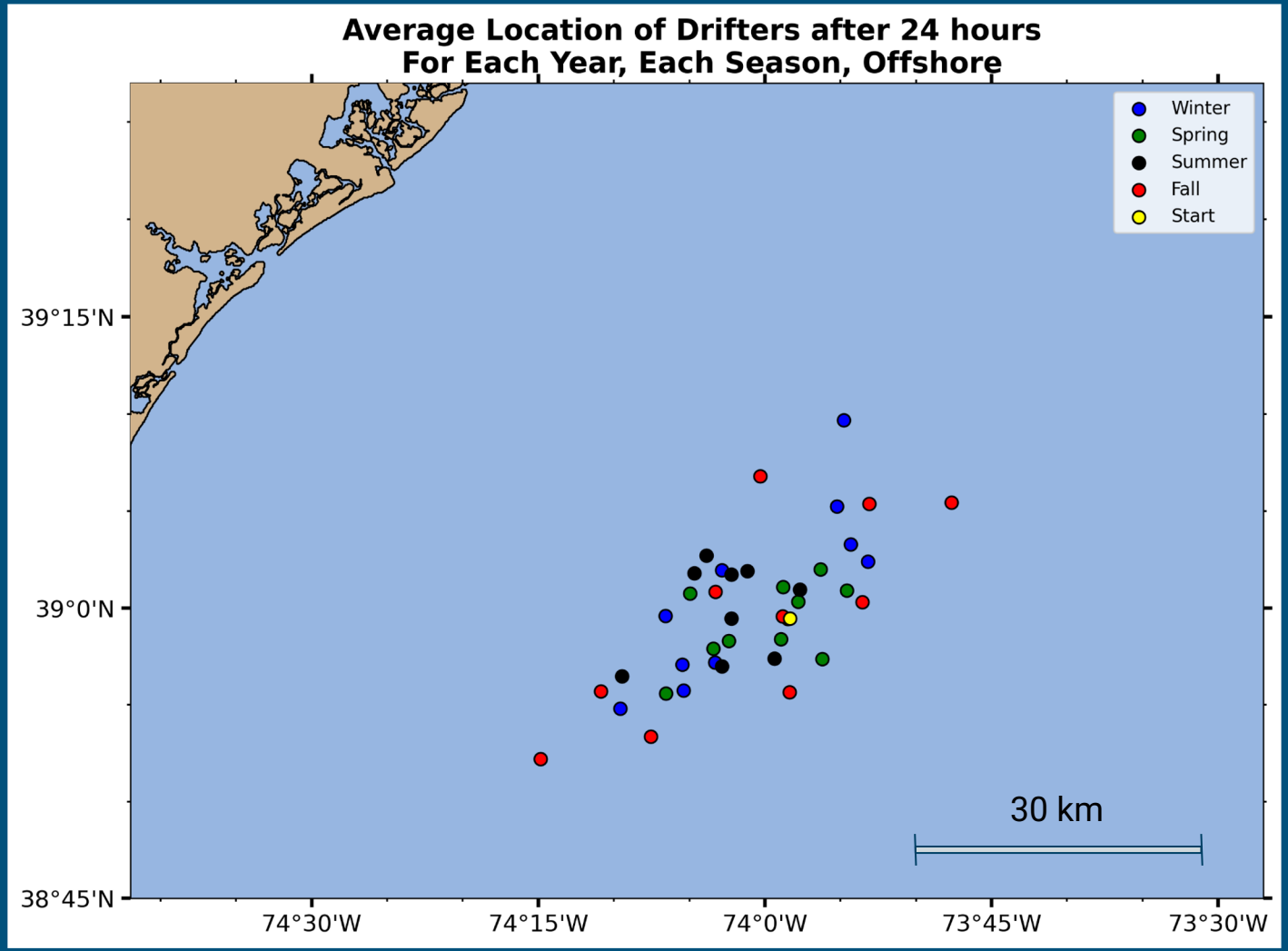
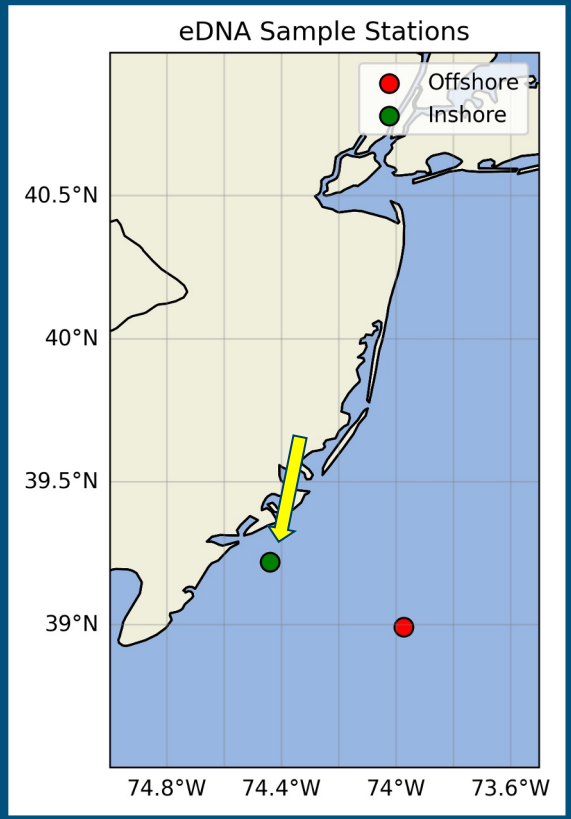
2009
2008
2007

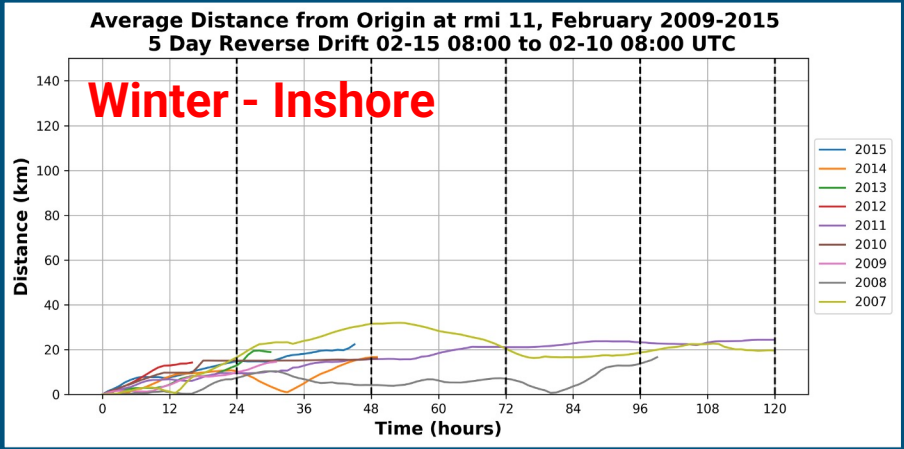
Map:

Offshore



Inter-Annual Variability: Inshore




Average Distance from Origin at rmi 11, February 2009-2015
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Winter - Inshore
Distance (km)
Time (hours)
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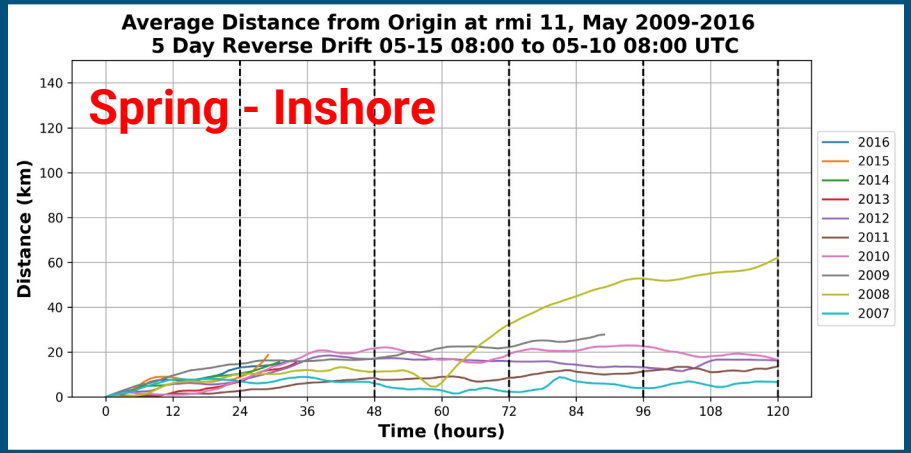
Average Distance from Origin at rmi 11, May 2009-2016
5 Day Reverse Drift 05-15 08:00 to 05-10 08:00 UTC
Spring - Inshore
Distance (km)
Time (hours)
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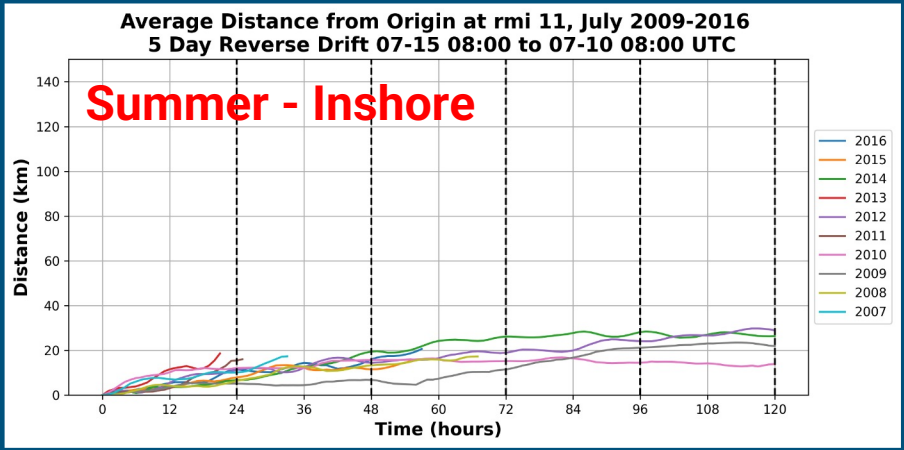
Average Distance from Origin at rmi 11, July 2009-2016
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Summer - Inshore
Distance (km)
Time (hours)
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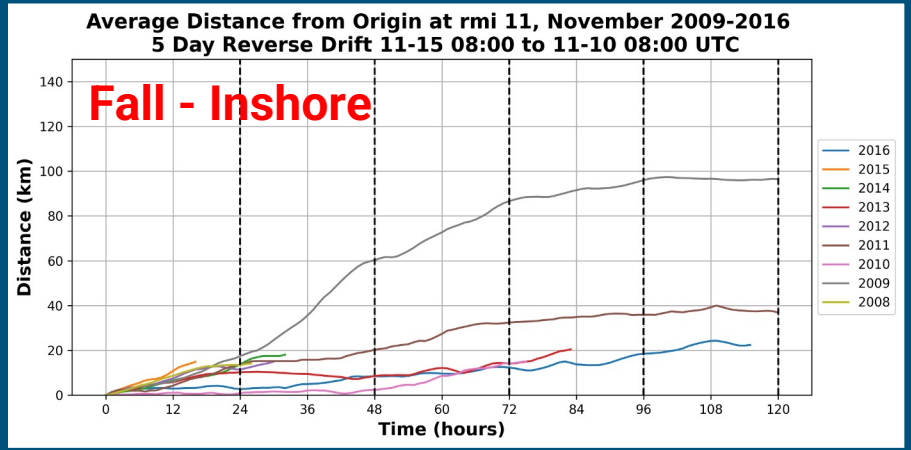
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Fall - Inshore
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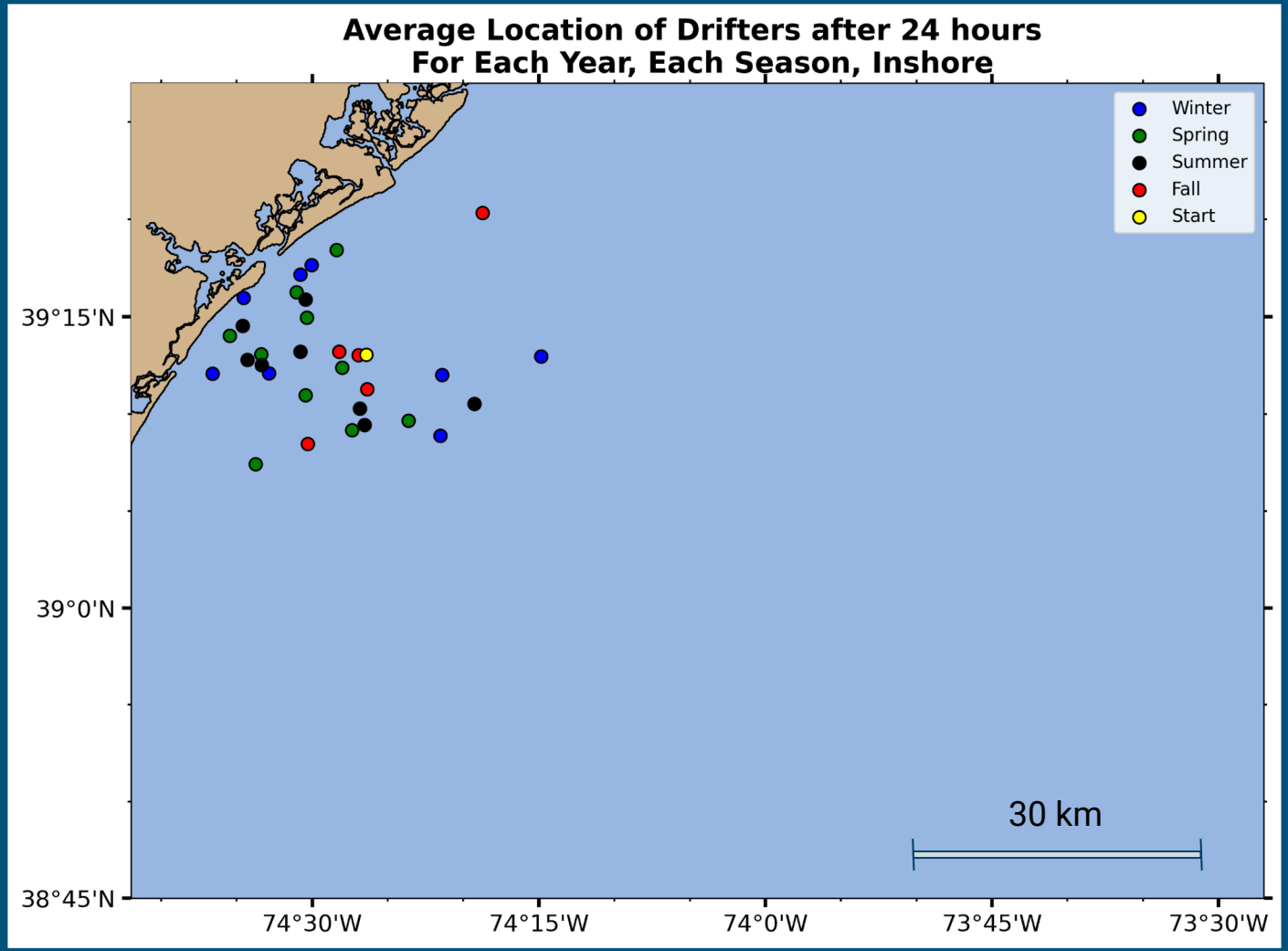
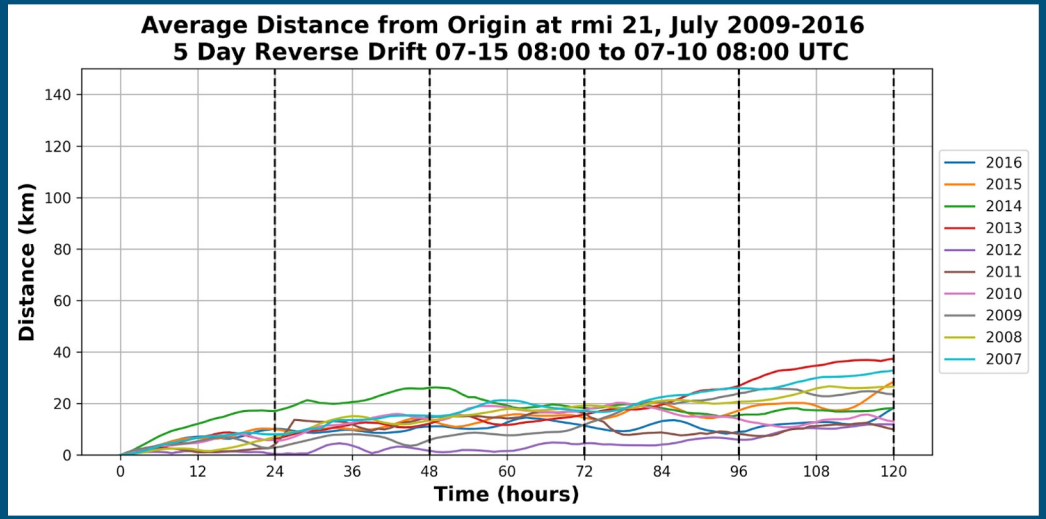
Map:

Inshore

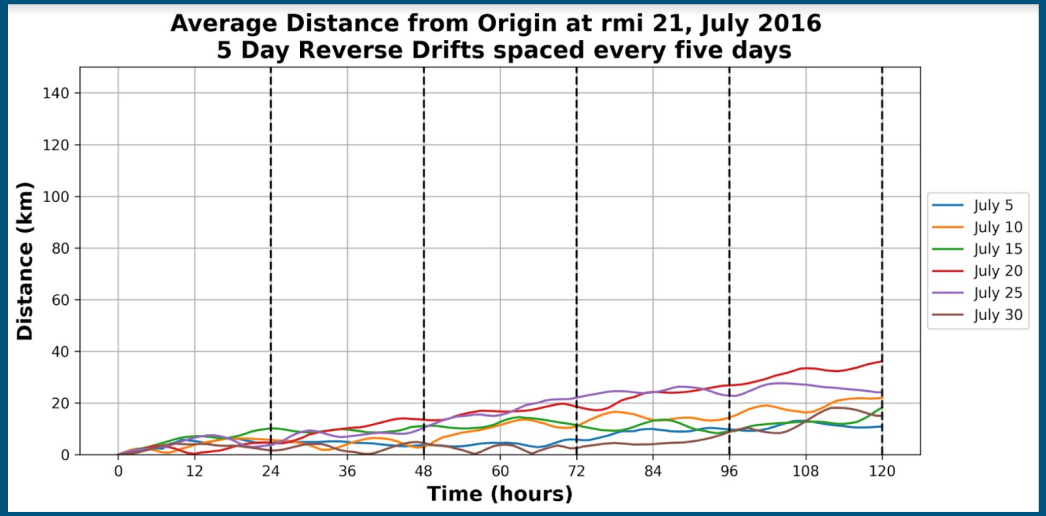

Average Location of Drifters after 24 hours
For Each Year, Each Season, Inshore
Winter
Spring
Summer
Fall
Start
39°15'N
39°0'N
38°45'N
74°30'W
74°15'W
74°0'W
73°45'W
73°30'W
30 km

Intra-Month Variability

- Small differences



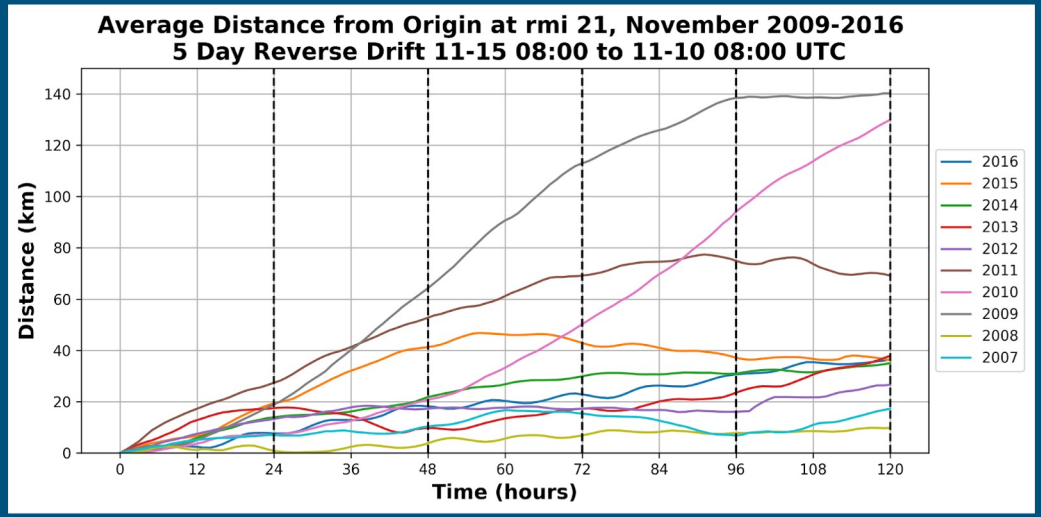
Same day of month, different years



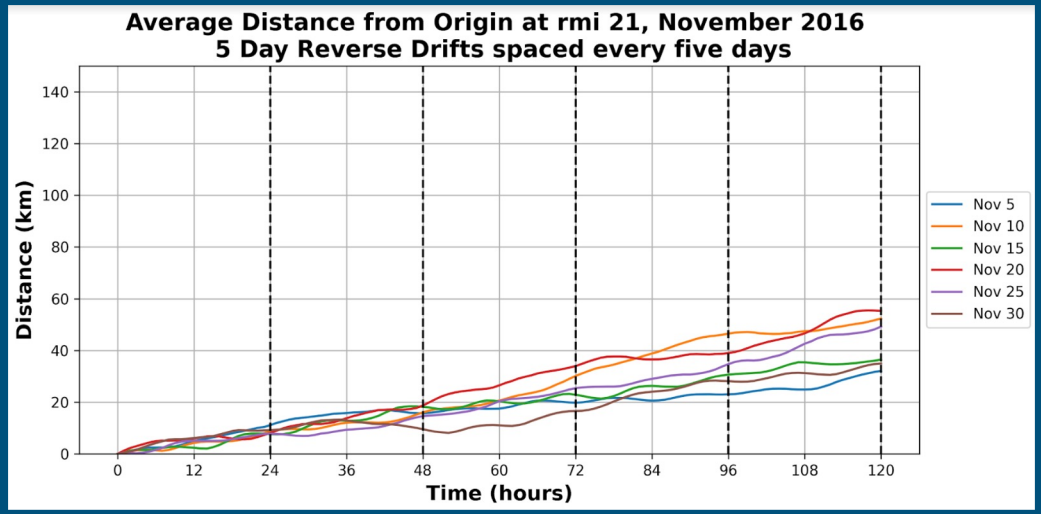
Same year, different days of month

Intra-Month Variability

- Differences between years



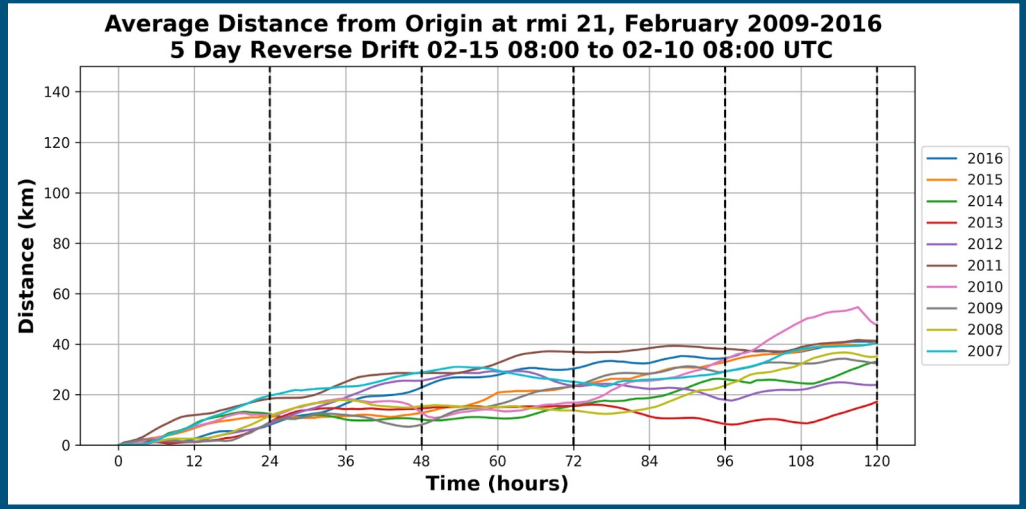
Same day of month, different years



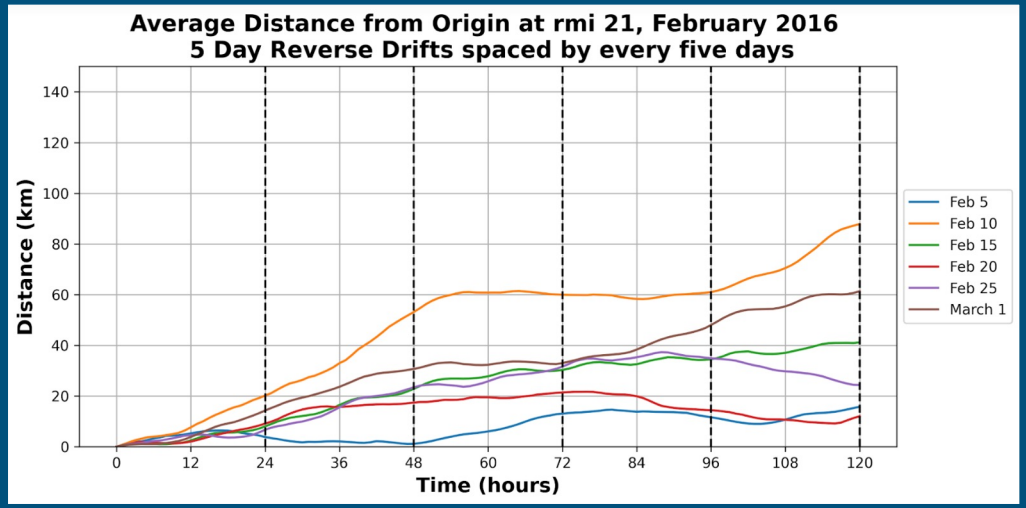
Same year, different days of month

Intra-Month Variability

- Differences within same month



Same day of month, different years



Same year, different days of month

Conclusions

- Based on this analysis most eDNA half life (~24 hours) travel distances were around 10 km.

- The seasonal variability of half life eDNA travel distances beyond 24 hours was larger than differences between locations.

- Events like storms can lead to much larger half life eDNA distances compared to seasonal means, especially in the fall.

At 24 hours mark:

- Offshore, current flows in the along shore direction. Inshore, many currents come from the coast.
- Fall and winter span a wide area above and below sample location, while spring and summer drifts form a tighter spread around it.