State of the Bays 2022
Summary of Indicators

STAC Meeting April 13, 2022

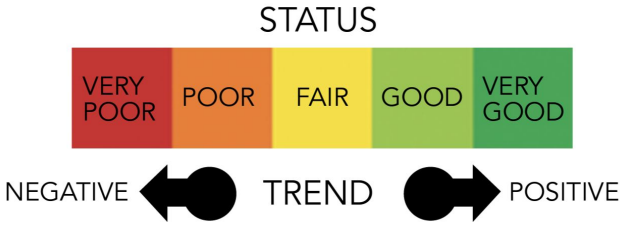
DELAWARE CENTER FOR THE
INLAND BAYS
Research. Educate. Restore.

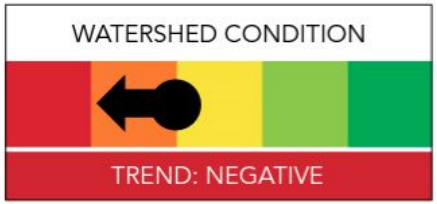
Today's Goals

- Summarize the results of indicator analyses, including status and trends
  - *Most were reviewed in subcommittee*
  - *Tech reports/presentations available for additional reviews*
- Discuss conclusions, record additional feedback
- Concurrence from STAC on current status and LT/ST trends for each indicator ***and*** each chapter as a whole
- Presentation to the Board on June 10th
- Report publication at end of summer

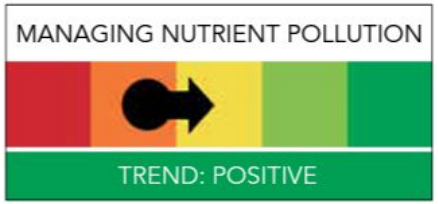
Indicator Status and Trends

- 2106: Gave an overall status/trend to each chapter - based on ‘best professional judgement’
- Consider status/trends for each indicator this time and derive an overall summary for the chapter





Development driven by rapid population growth is increasing the acreage of impervious surface coverage, adding to urban pollution sources, and stressing habitats. Agricultural pollution is decreasing as land uses change. Increased flushing at the inlet has improved water quality in open Bay waters.

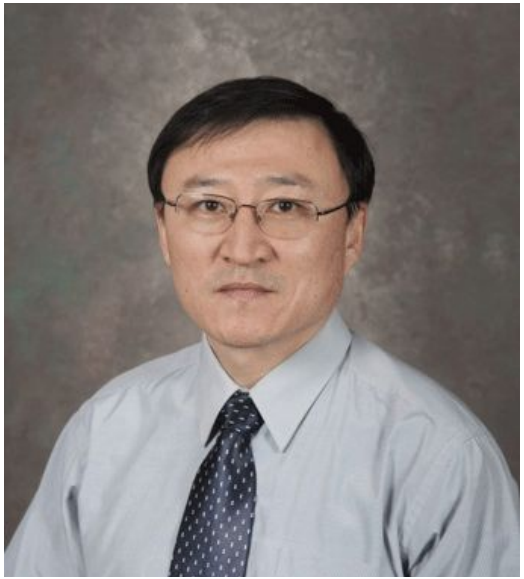


The remaining two point sources of nutrients should soon be removed from the Bays. Nonpoint source pollution remains above healthy limits. Septic conversions to central sewer have exceeded goals set in the Pollution Control Strategy, but other management progress has stagnated since 2011.

Water quality is improving in Little Assawoman Bay and in open waters near the Indian River Inlet. Algae and seaweed blooms have improved in some areas, but tributaries and canals are still murky and oxygen-starved.

Discussion Agenda

- Fengyan Shi – Indian River inlet tidal prism model
- Water quality and nutrient load indicators - decisions on trend analyses
- Remaining indicators: watershed condition, living resources, human health risks, climate
- Concurrence from STAC on indicators, status and trends
- Next steps



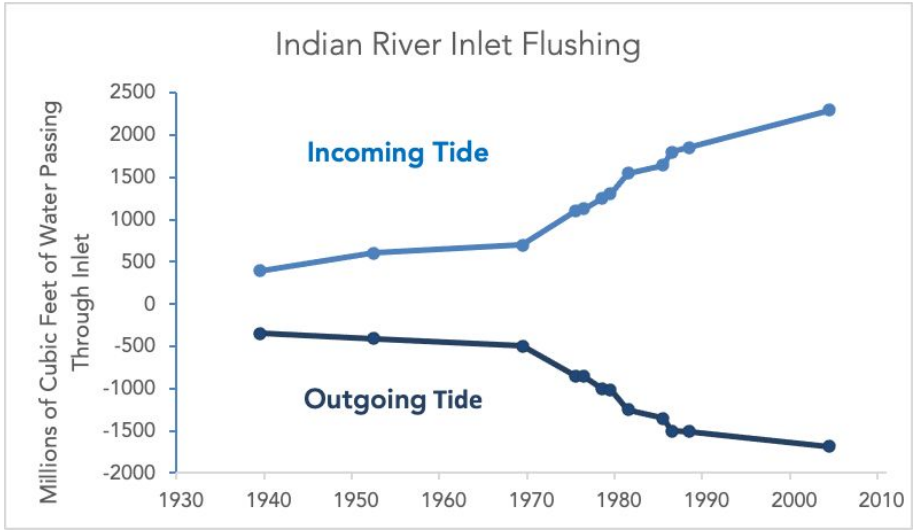
Prof. Fengyan Shi
University of Delaware

Department of Civil and Environmental Engineering
Center for Applied Coastal Research

Indian River Inlet Tidal Flushing

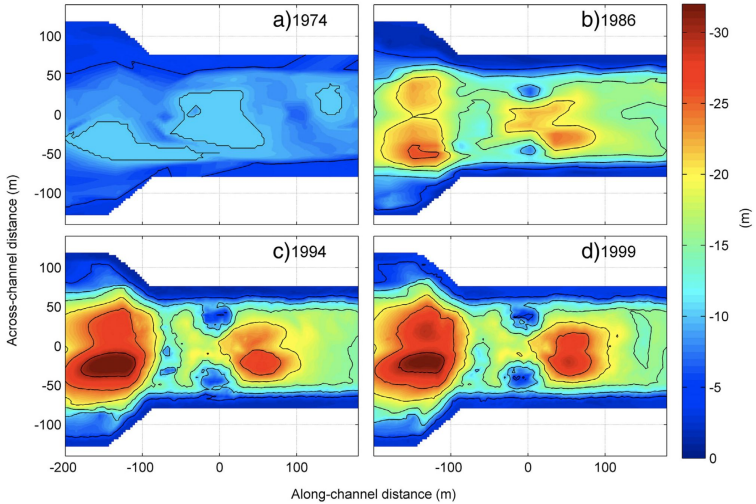
- Until 1928, inlet moved along a two-mile stretch of the coast.
- Stabilized by USACE 1938.
- Five bridges. Scouring first noticed in1980s. Deepened over time.
- Greater volumes → LT salinity increase and contributes to marsh degradation
- Also flushes more pollutants

IR Tidal Prism

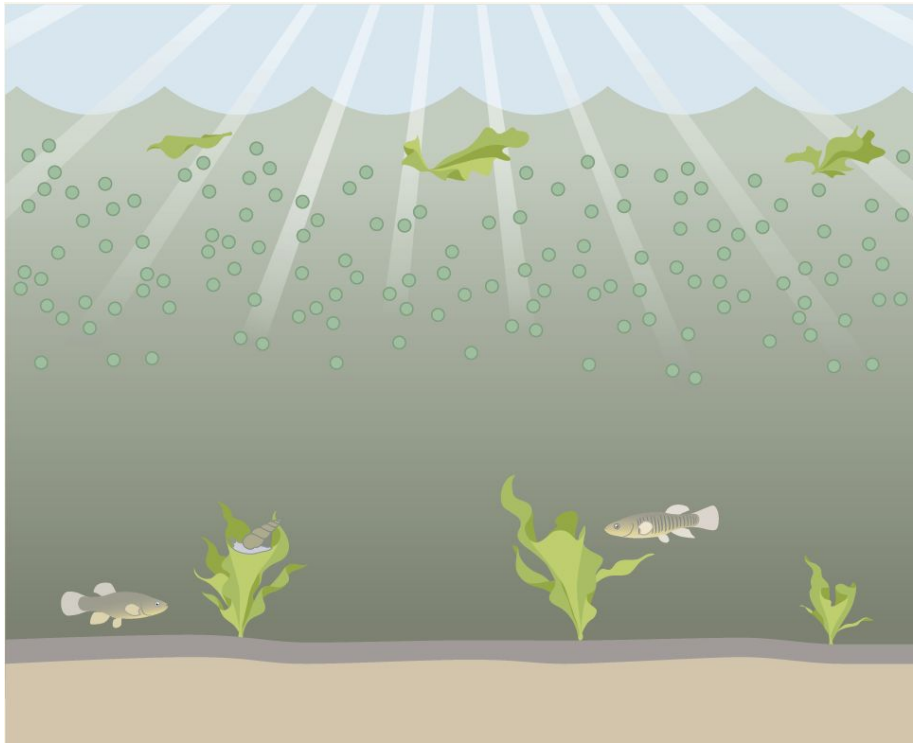


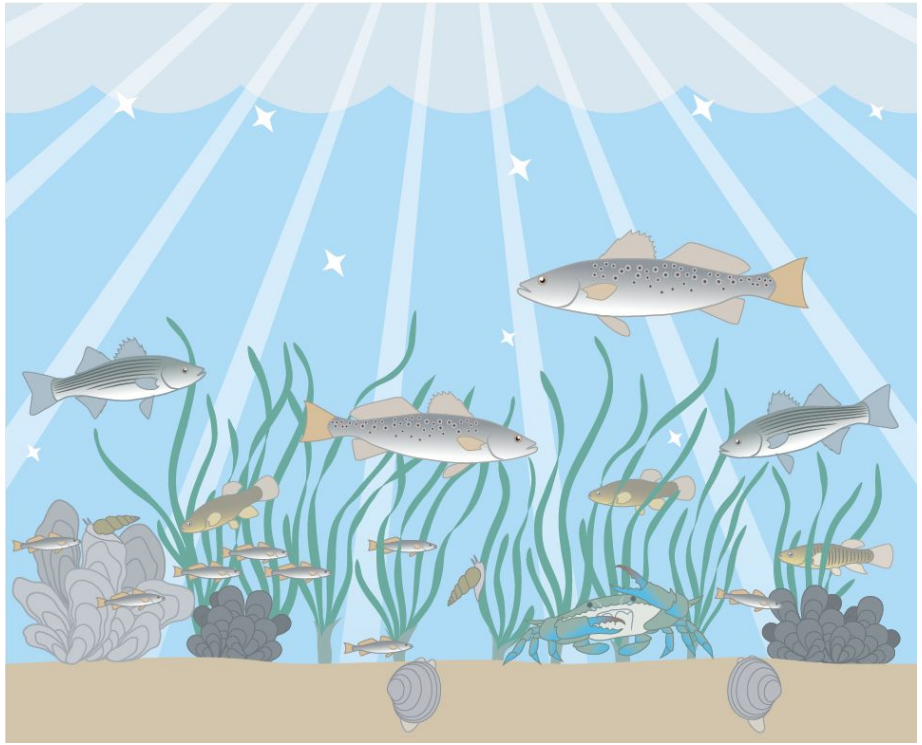
"Tidal Prism" = Volume of water leaving an estuary at ebb tide (or volume of incoming tide + river discharge)

- Last physical measurement was 2004 by the USACE
- Scour huge issue with the previous inlet bridge
- No funding to re-do measurement
- STAC/USACE recommended a modeling approach



WATER QUALITY



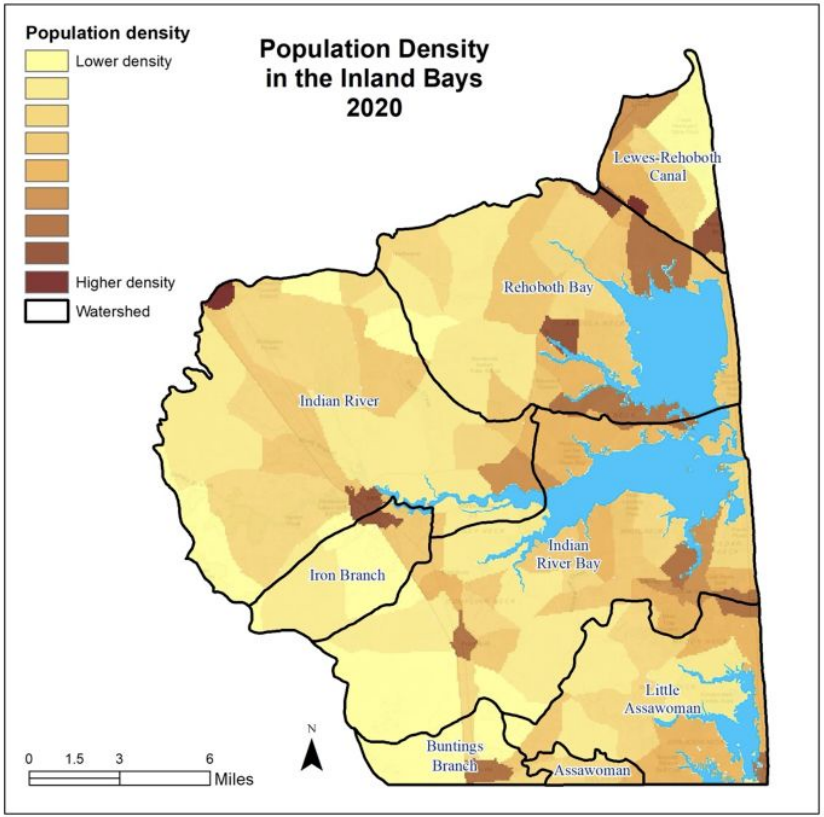


MANAGING NUTRIENT POLLUTION

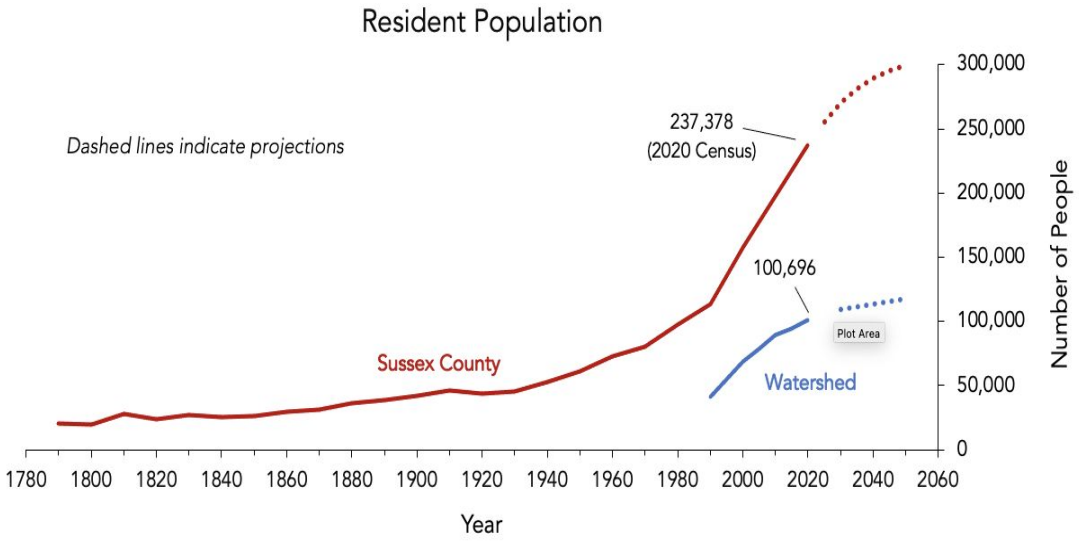
WATERSHED CONDITION

Human Population Growth

- Planning for growth impacts
- Data: U.S. Census, DE Pop. Consortium *(projections)*, Office of State Planning Coord *(TAZs)*
- FT densities highest in developed coastal areas



Human Population Growth - Summary



STATUS - FAIR

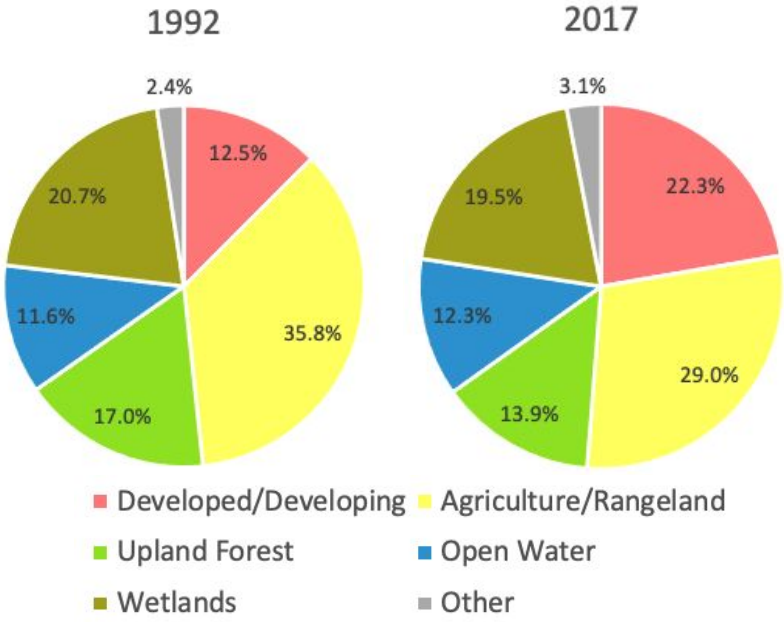
- 42.4% of Sussex residents live in the IB w.s

TREND - DEGRADING

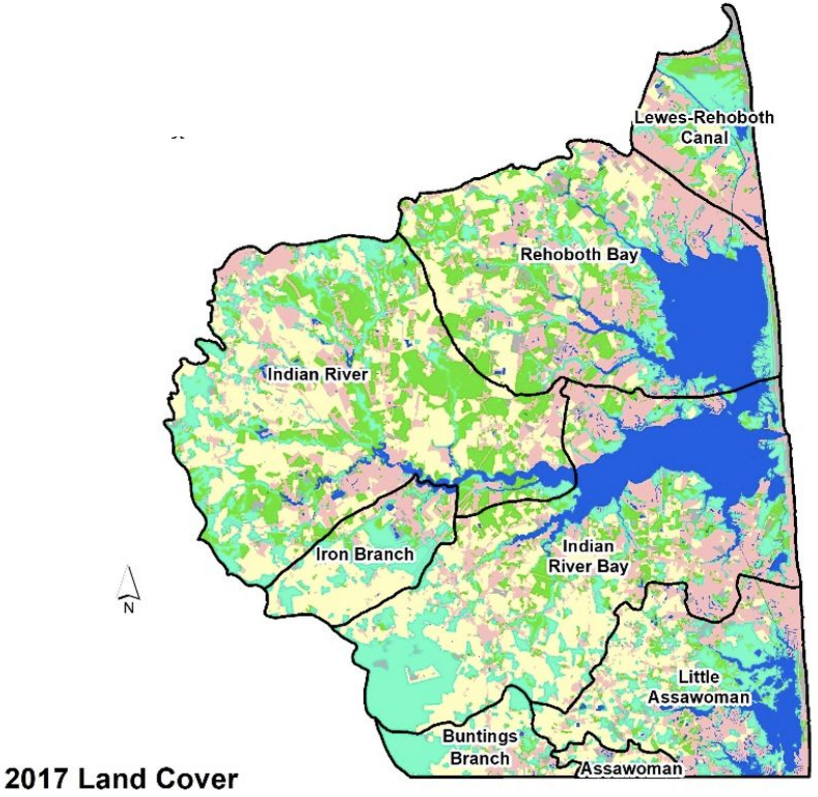
- **LT** – Sharp increase since 1990, with coincident changes in LU
- **ST** – Continued growth in full-time residents and development *(13% increase since 2010 - higher than projected)*; current development signals ongoing trend

Land Use Change

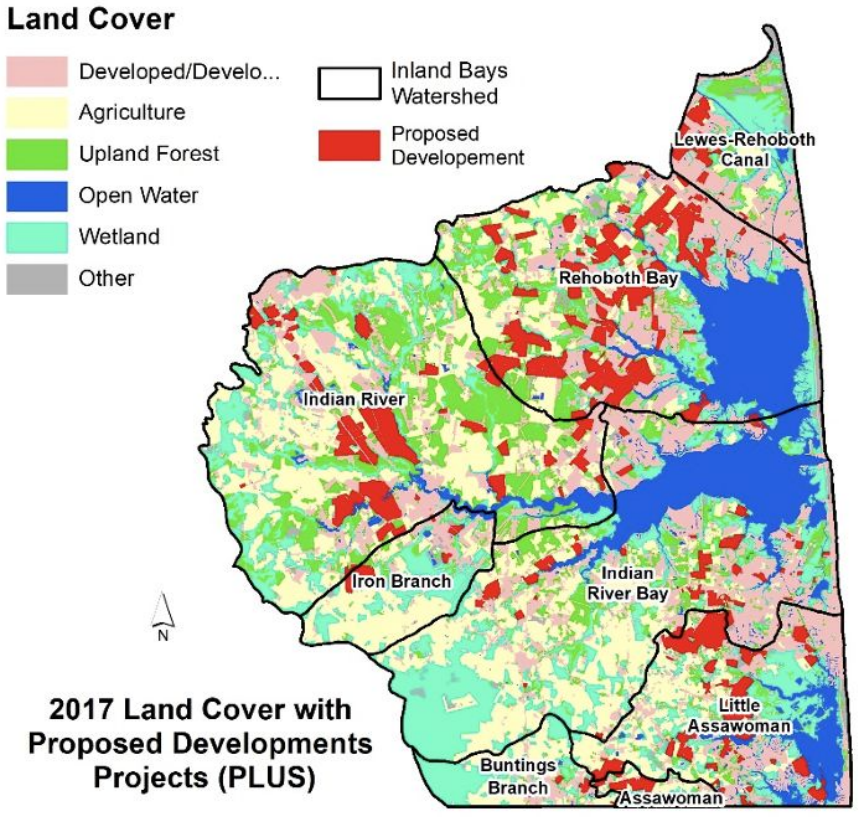
- Land use directly affects water quality
- LULC data 1992-2017
- Six-categories to match previous reports



Land Use Change - Proposed Development



2017 Land Cover



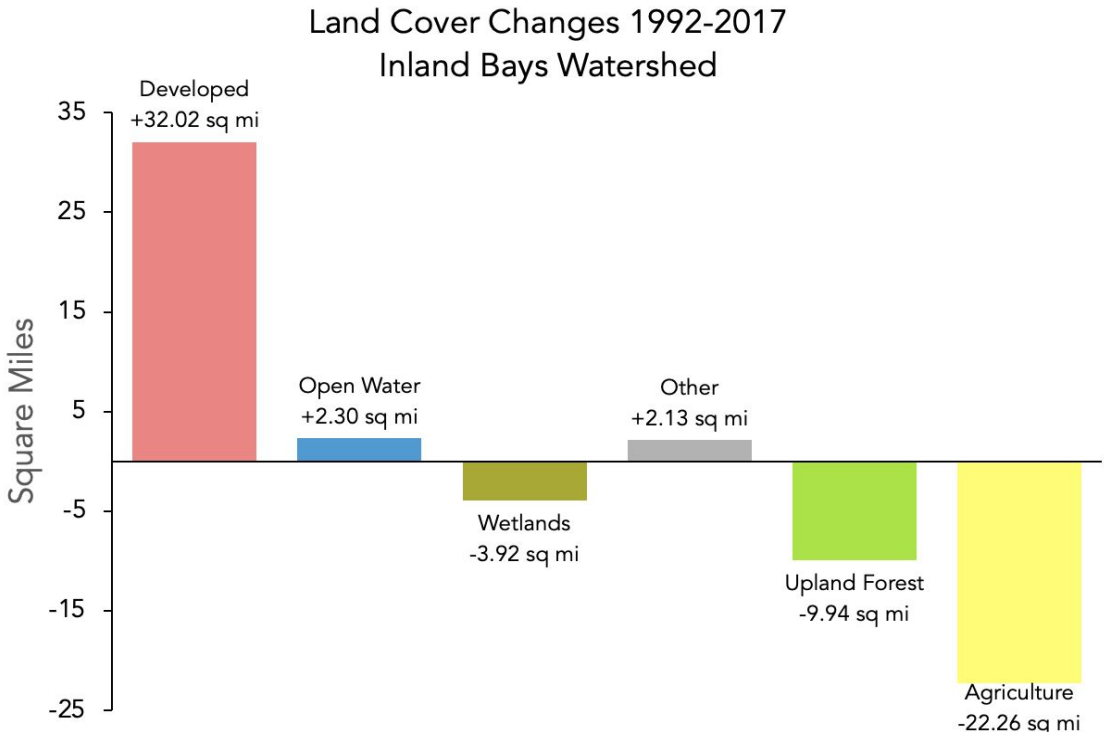
2017 Land Cover with Proposed Developments Projects (PLUS)

Land Use Change

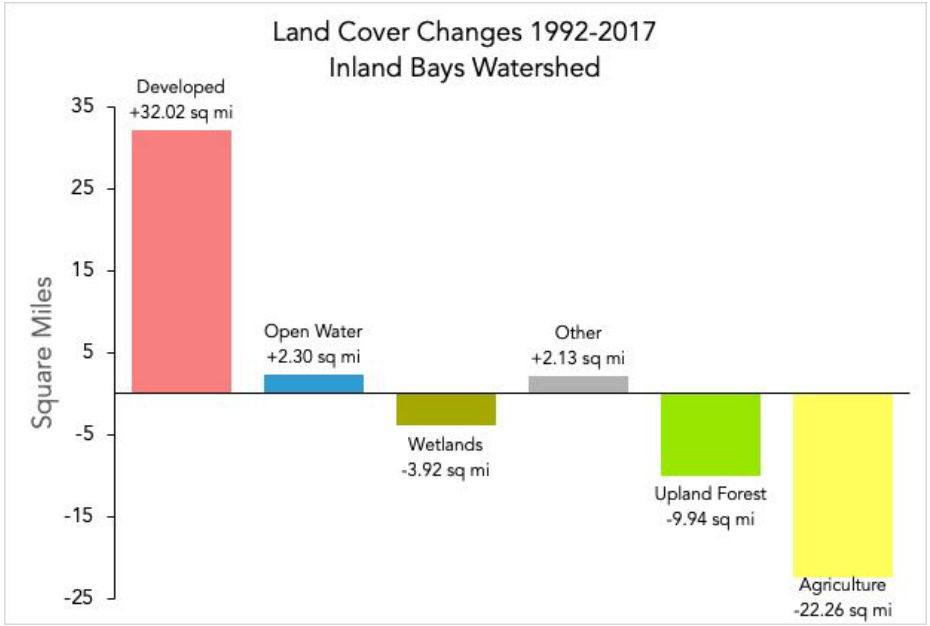
- Agric. still the largest LU; but forest and agric being converted to development
- On average, agric. lands contribute highest nutrient loads/ac

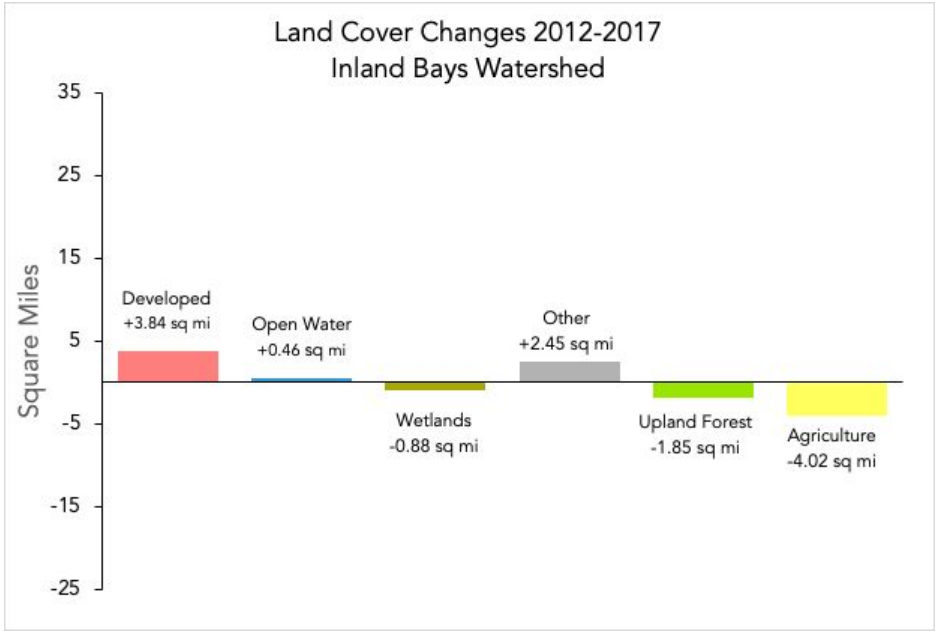
1992 to 2017:

- 18% loss in forest
- 6% loss in wetlands
- 19% loss in agriculture
- 78% increase in developed/developing



Land Use Change





Land Use Change - Summary

STATUS - FAIR

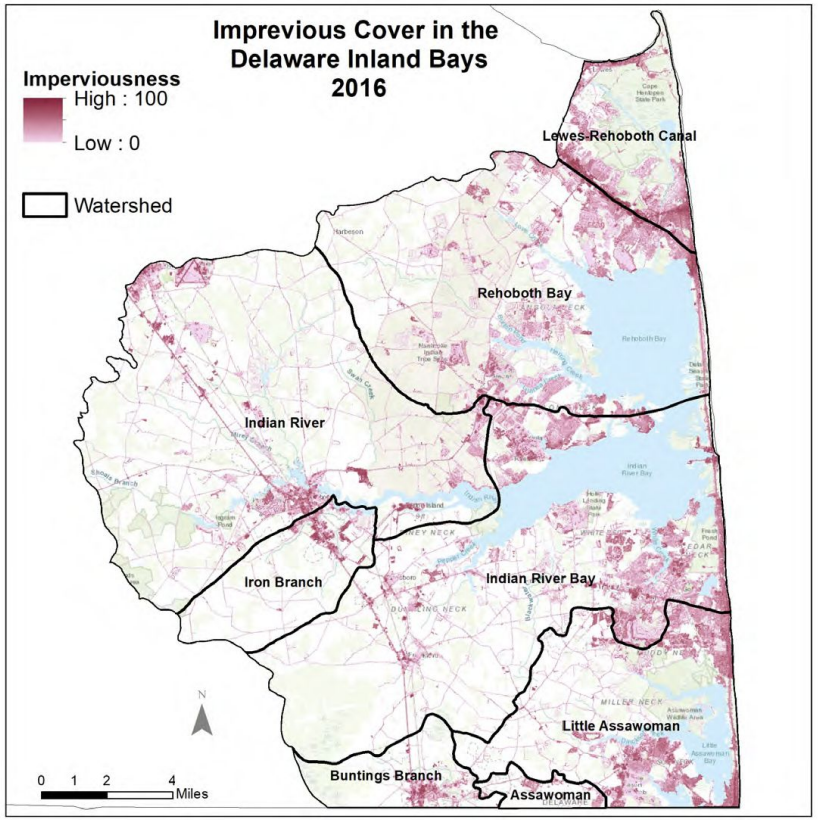
- Developed land is replacing agriculture and forested Habitat; much of the development is near waterways (*quantify*)

TREND - NEGATIVE *(loss of forest, lack of buffers, infrastructure/habitats)*

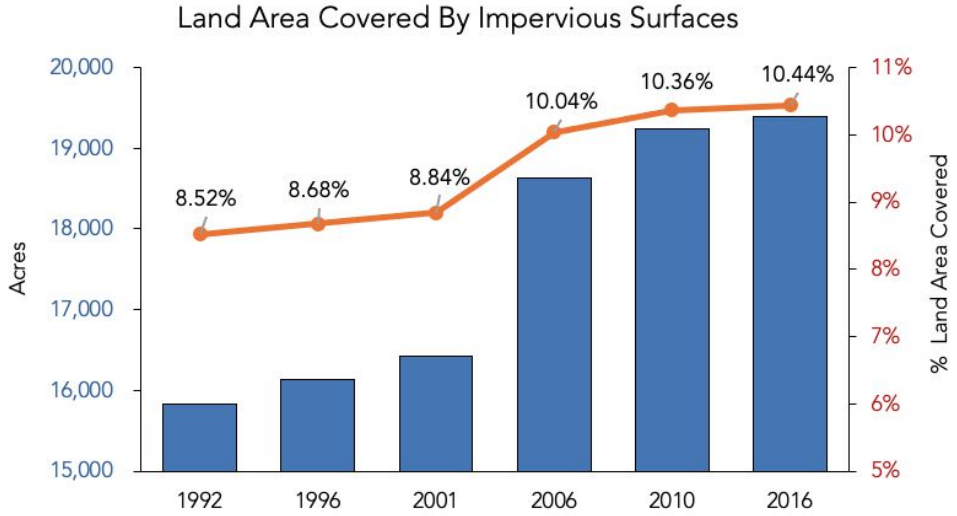
- **LT** – Direction of losses/gains consistent over time
- **ST** – Changes 2012-2017 slowed slightly compared to previous years. <u>But</u> large uptick in construction began around 2016/2017
- Emphasizes the need for land conservation and buffers

Impervious Surface Coverage

- Correlated with development; increased 22.5% since 1992
- Concentrated near the Bays. Rises to 60-80% in urban areas
- 10% IC generally cited as a threshold for watershed health impact, >25% non-supporting
- Likely not relevant for our watershed; WQ impacts unknown



Impervious Surface Coverage



STATUS - FAIR

- Current overall estimate 10.44%; MUCH higher and impactful in more urbanized areas of the Watershed

TREND - NO TREND

- **LT** – Since 1992, percentage IC in watershed increased by 22.5%
- **ST** – Overall, IC increased by only 144 acres between 2010 and 2016; but larger increases in certain smaller areas of development

Water Quality Buffers Width

Buffers:

- *Improve/protect water quality*
- *Provide habitat*
- *Enhance/maintain flood plain storage*
- *Allow marsh migration with SLR*

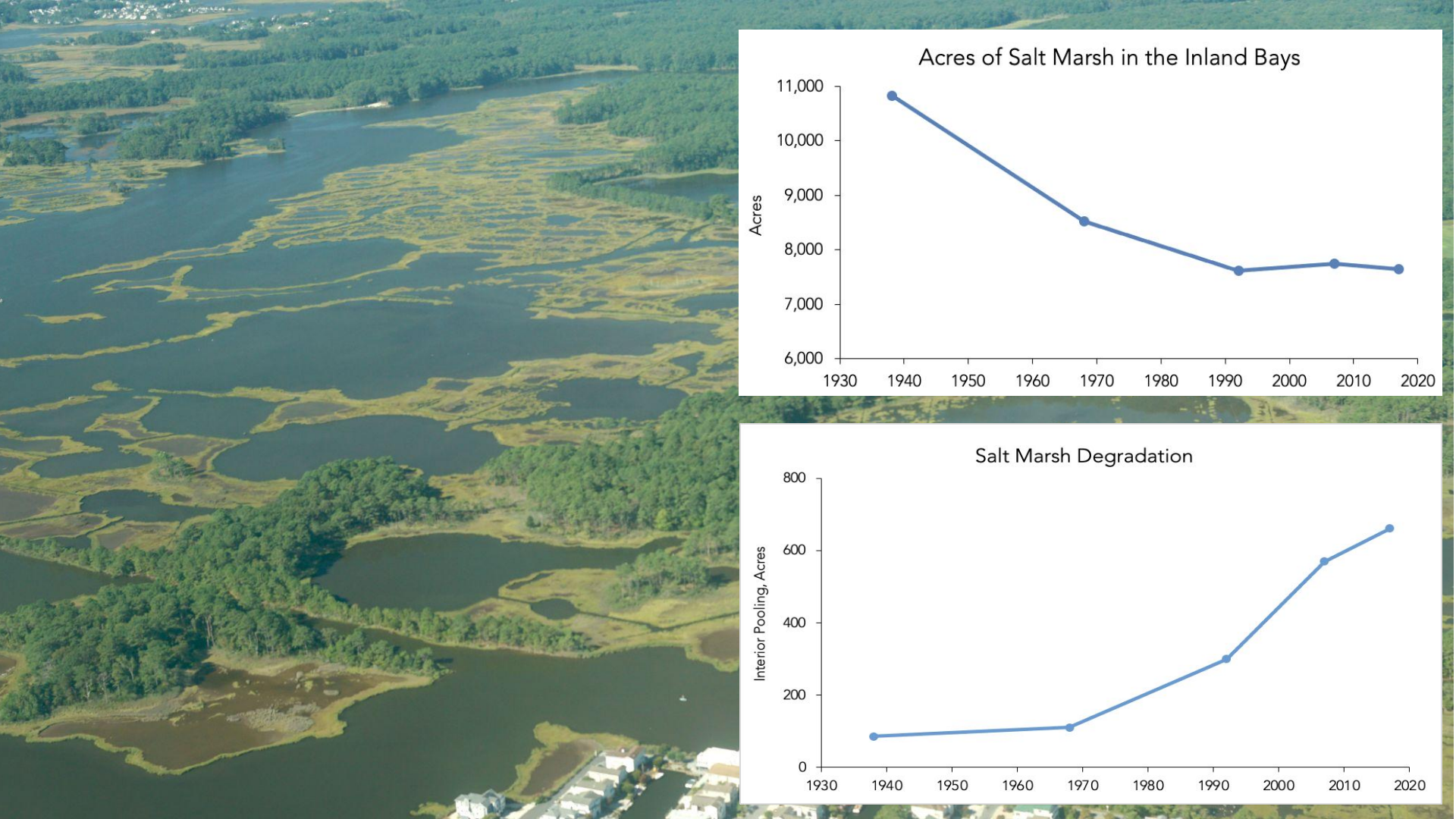
Mean width of forest/wetland buffers on croplands used as an indicator in 2016.

To be dropped in 2022, due to irreconcilable data conflicts.

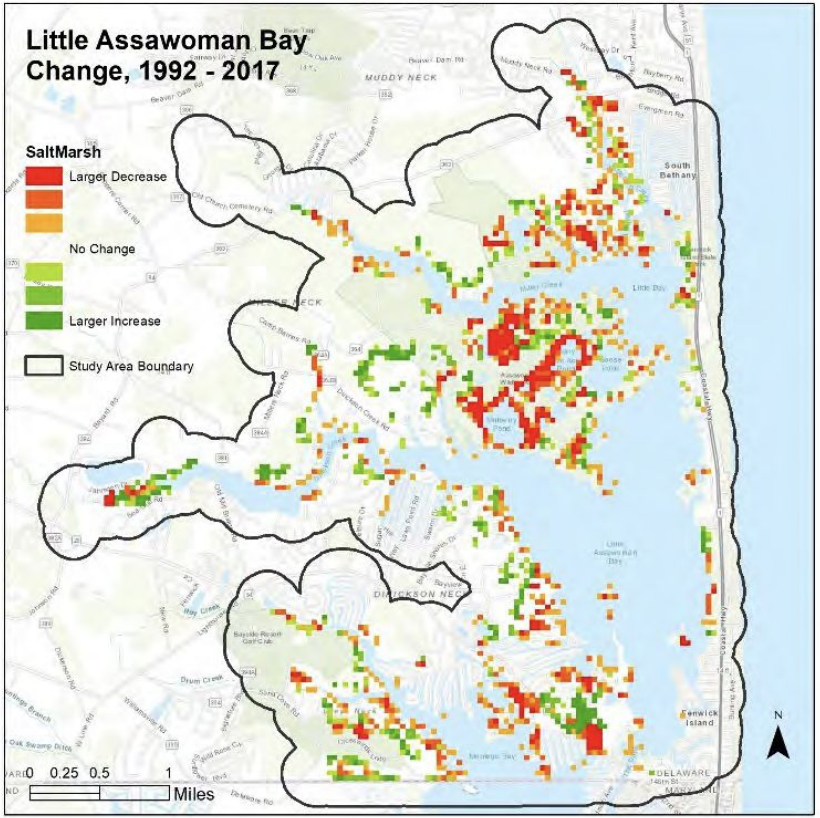
Provide information on importance and connect to forest loss.

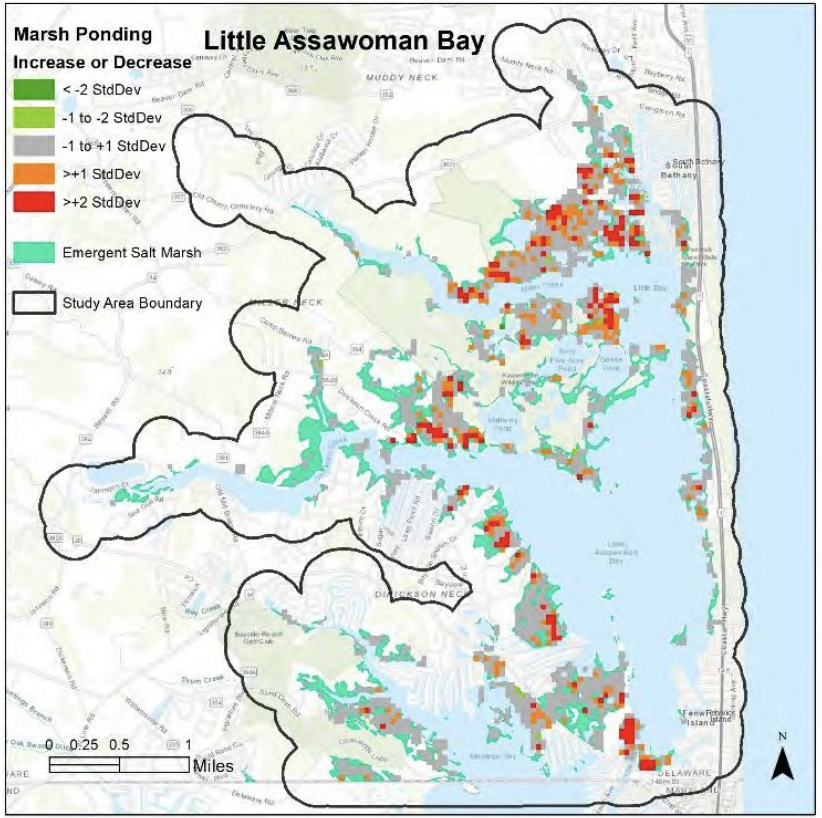
Salt Marsh Acreage and Condition

- Critical for: habitat, carbon storage, coastal resiliency
- Threatened by SLR, erosion, barriers to migration
- Two indicators (based on 1992-2017 aerial imagery):
  - *Total acreage of tidal wetlands*
  - *Interior open water ponding, or 'fractured pooling'*


Acres of Salt Marsh in the Inland Bays
Acres
11,000
10,000
9,000
8,000
7,000
6,000
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
Salt Marsh Degradation
Interior Pooling, Acres
800
600
400
200
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

Areas of Greatest Acreage Change, 1992-2017





Salt Marsh Acreage and Condition

STATUS - FAIR

- Lost 3,200 acres, or 30% since 1938. Area of interior open water increased 770% (from 86 acres to 661 acres).
- LT monitoring results show some areas holding, for now.

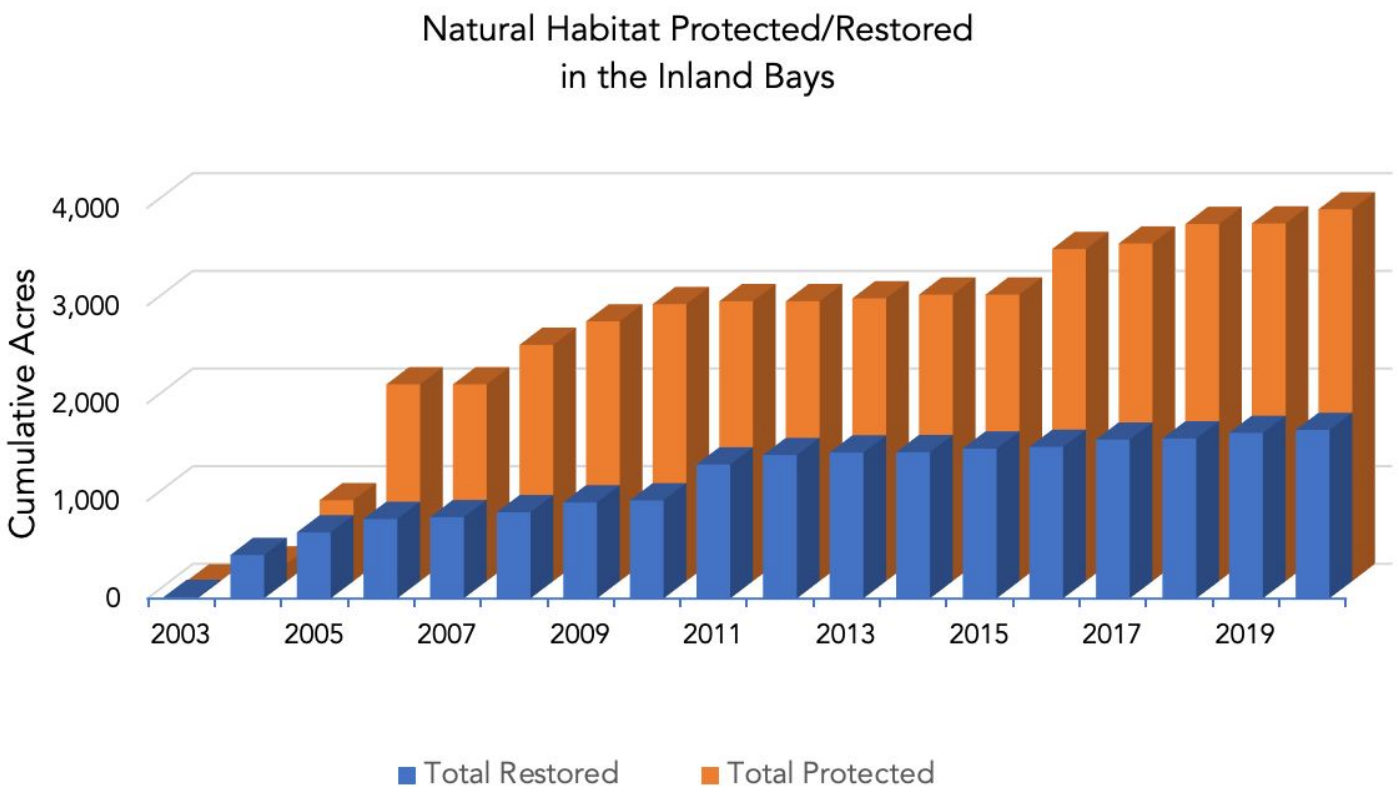
TREND - DEGRADING

- **LT** – Major area losses slowed in 1970's after Wetlands Act protection. Marked increase in fractured pooling after 1970, and accelerating.
- **ST** – Overall acreage fairly stable, but clear increase in open water ponding, indicating a loss of marsh integrity and function. Changes especially pronounced in LAB and western RB.

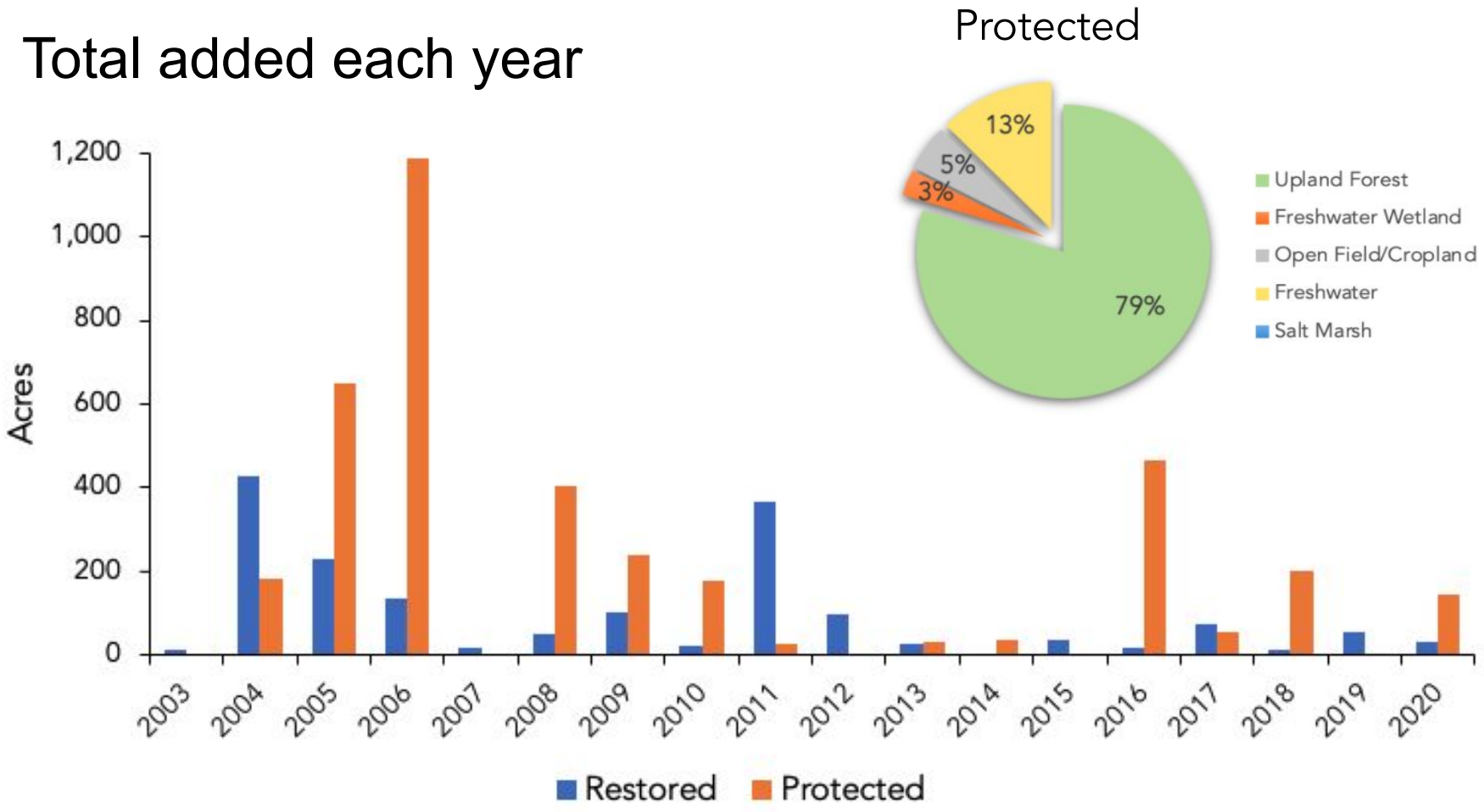
Natural Habitat Protection and Restoration

- Tracks progress in addressing habitat loss and degradation
- Acres added, by year: lands/habitat permanently conserved, restored, or enhanced
- NEPORT database source

Includes land acquisition, conservation easements, wetland and shoreline restorations, reforestation, baygrass restoration, reef creation, invasives control, etc.


Natural Habitat Protected/Restored
in the Inland Bays
Cumulative Acres
4,000
3,000
2,000
1,000
0
2003
2005
2007
2009
2011
2013
2015
2017
2019
Total Restored
Total Protected

Total added each year



Protected

Natural Habitat Protection/Restoration

STATUS - GOOD to FAIR

- 873 acres added 2016-2020, 819 ac of which was forest.
- >8.5 x more funding put toward land conservation in past five as in previous twelve years.

TREND - IMPROVING

- **LT** – Pace of land protection stalled between 2010 and 2015.
- **ST** – Pace increased since 2016. Current focus on land conservation by many partners likely to accelerate even more.

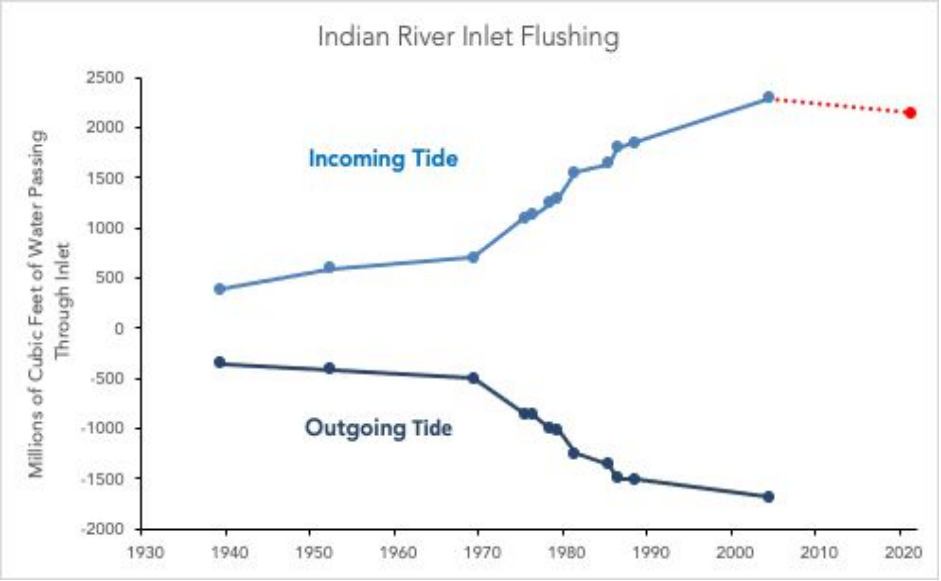
Indian River Inlet Tidal Flushing

STATUS - ??

- Scouring mitigated by removing bridge piers
- Current estimated max tidal prism ~2,150 million ft^3, likely has stabilized

TREND - NO TREND

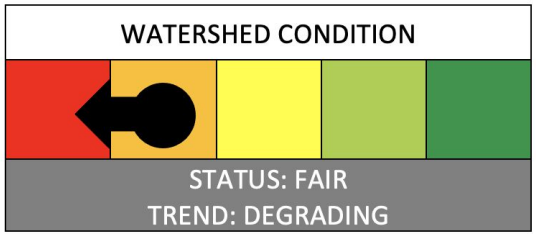
- **LT** – Large increase over last 80 years, impacting the Bays
- **ST** – No significant change since 2004; volume may increase with SLR



Overall Status and Trends - Watershed Condition, 2016

Development driven by rapid population growth is increasing the acreage of impervious surface coverage, adding to urban pollution sources, and stressing habitats. Agricultural pollution is decreasing as land uses change. Increased flushing at the inlet has improved water quality in open Bay waters.

Overall Status and Trends - Watershed Condition, 2021

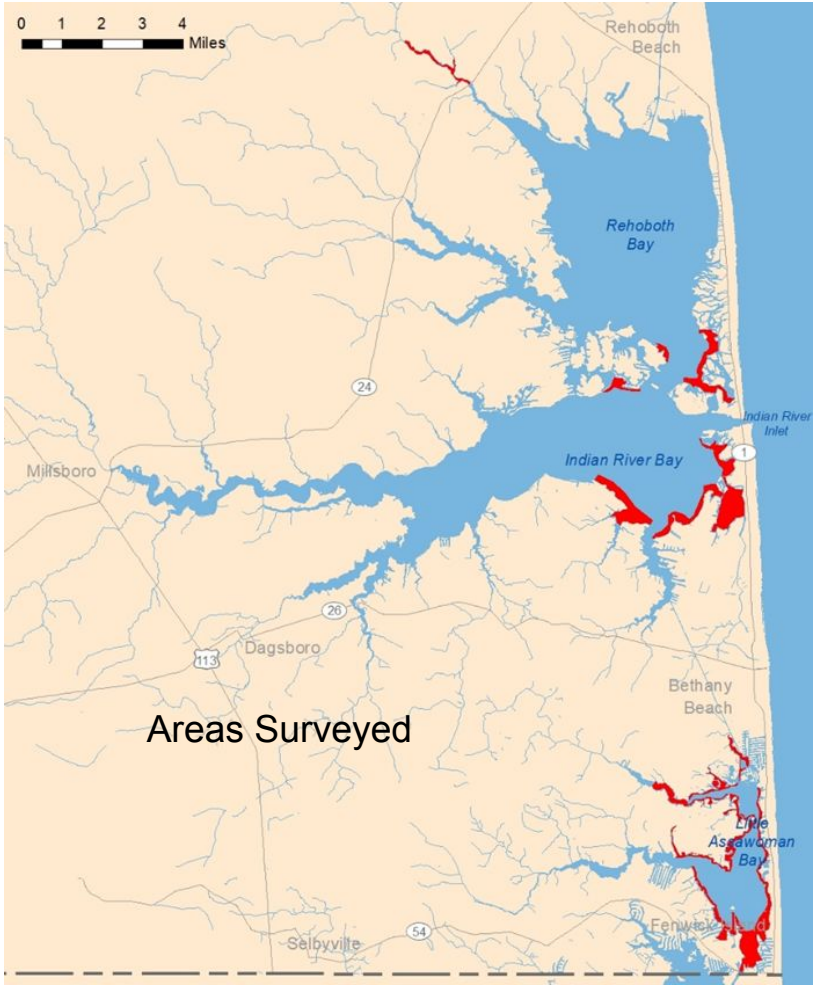


Indicator	Status	Trend (last 5 yrs)
Human Population Growth	Fair	Degrading
Land Use Change	Fair	Degrading
Impervious Surface Coverage	Fair	No Trend or Slightly Degrading
Salt Marsh Acreage and Condition	Fair	Degrading
Natural Habitat Protection and Restoration	Fair to Good	Improving
Indian River Tidal Flushing	?	No Trend

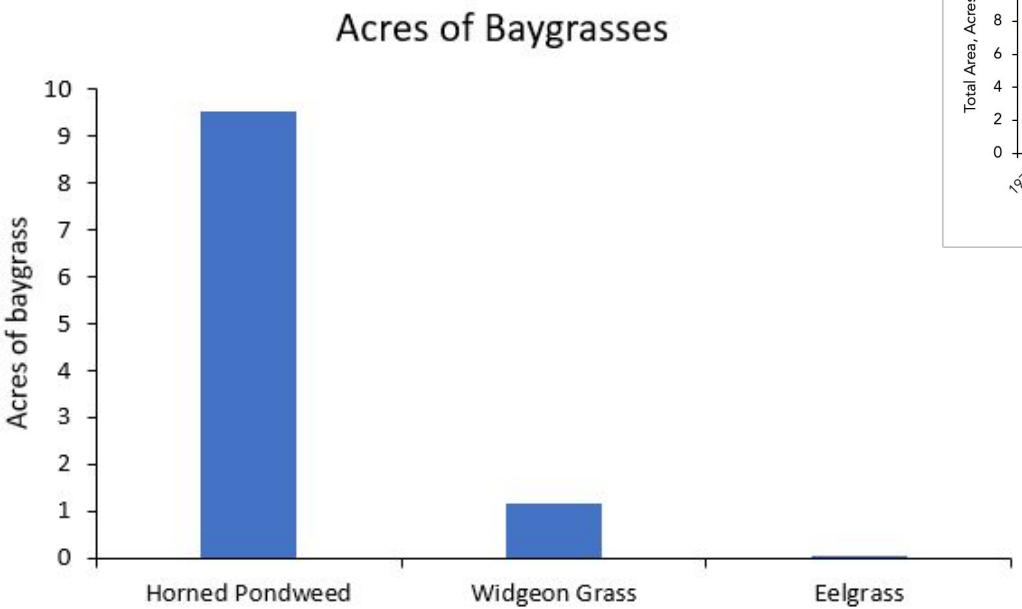
LIVING RESOURCES

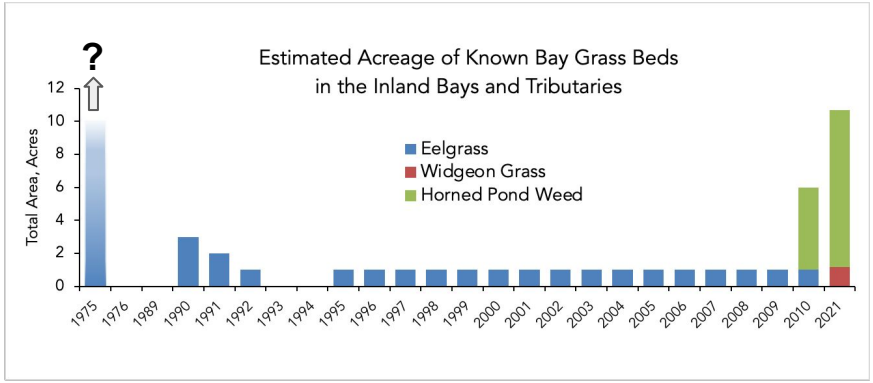
Baygrasses

- Critical habitat for a healthy estuary
- Water quality, blue carbon benefits
- Indicator of excellent water quality when present (esp. eelgrass)
- Declines from natural disease, eutrophication, lack of seed source – severely depleted in Inland Bays
- Surveyed by CIB 2020-2021



Baygrasses





- 10.69 acres total
- Estuaries to north and south support thousands of acres
- Mostly near seed sources

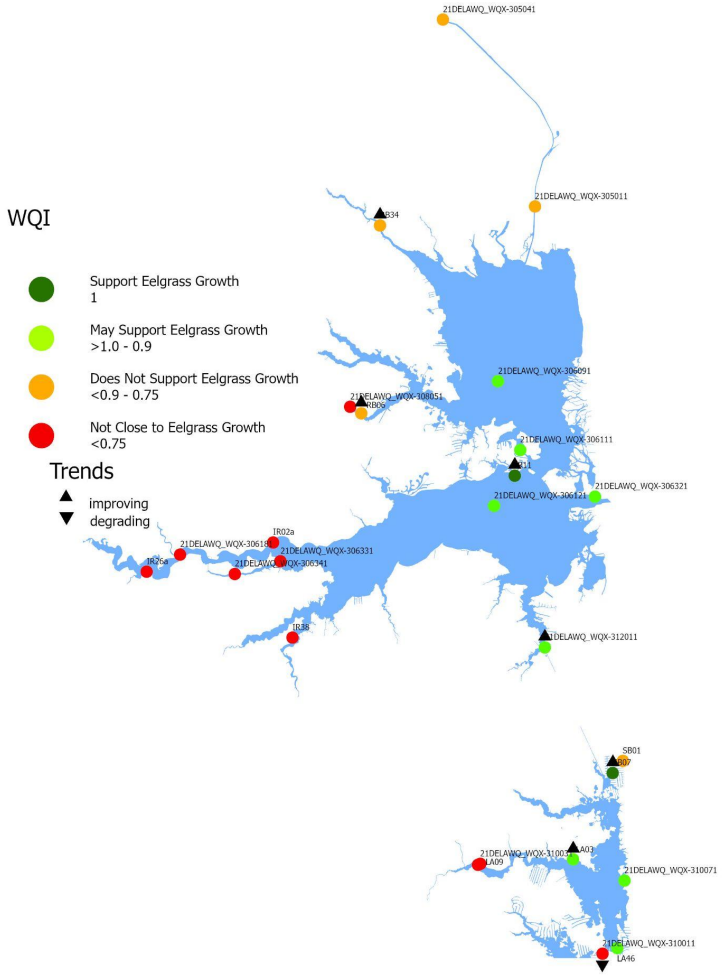
Baygrasses

STATUS – VERY POOR

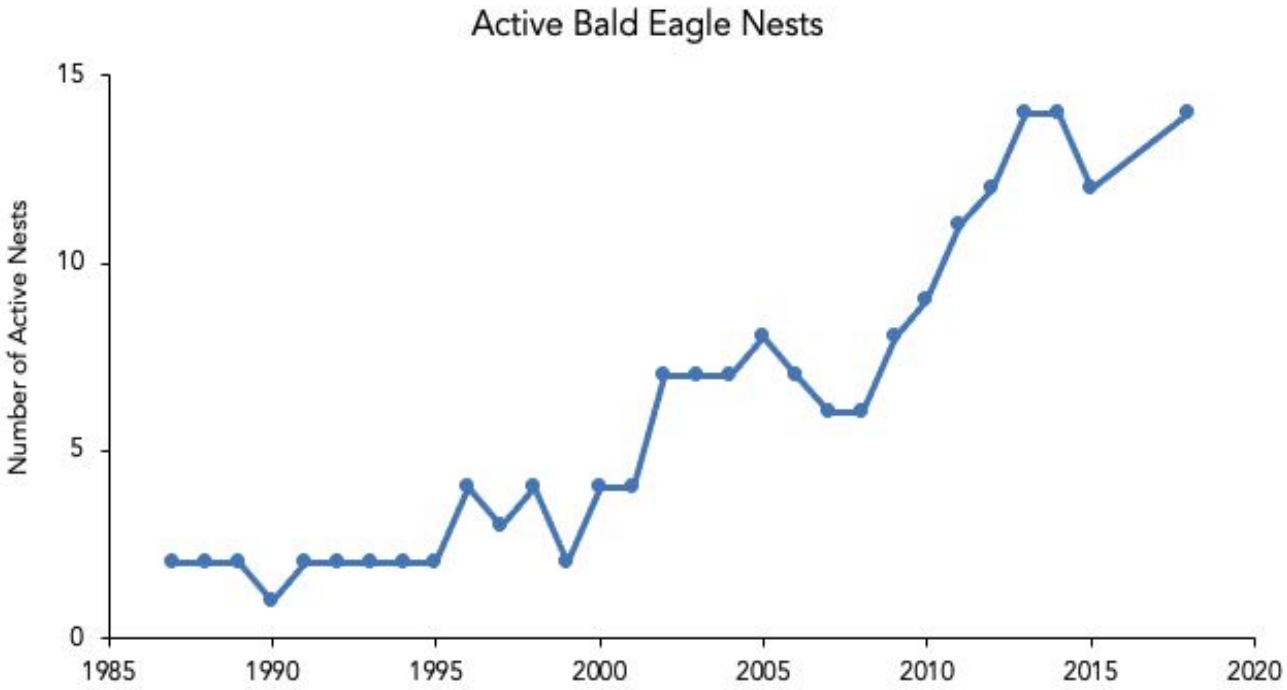
- Current acreage VERY low when compared to similar systems
- Eelgrass suitability index moved here

TREND - SLIGHTLY IMPROVING

- **LT** - No trend, has been below 11 acres since the 70’s
- **ST** - Improving slightly. Seeing signs of widgeon grass in LAB with some major bloom years



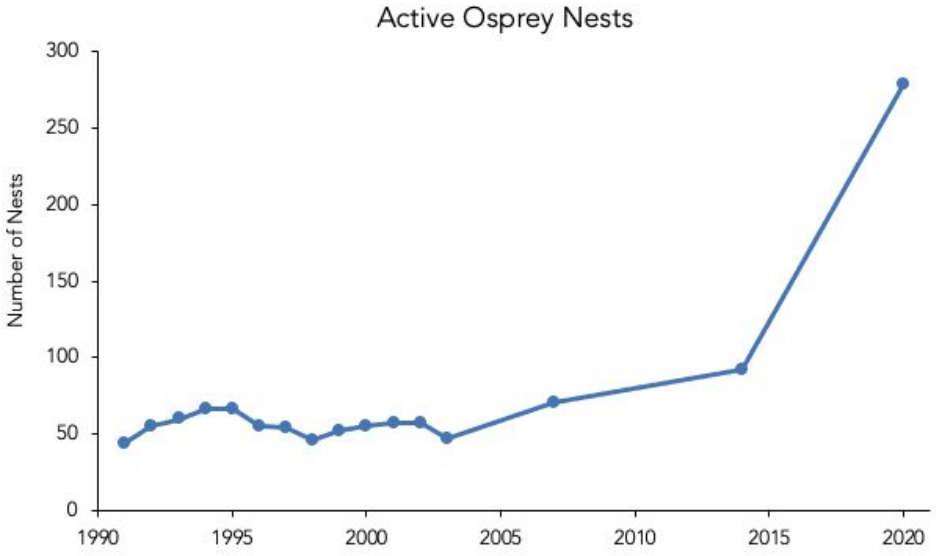
Eagle and Osprey Nesting

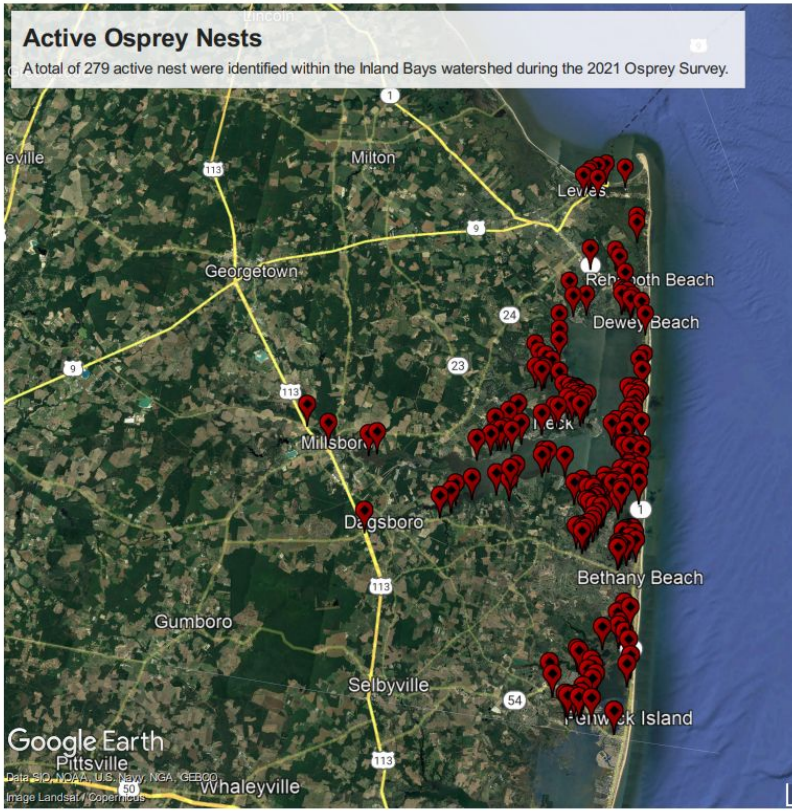


- Last survey 2018
- 14 active nests
- Stable trend

Eagle and Osprey Nesting

- Last DNREC survey 2014 (various methodologies) -http://www.osprey-watch.org/
- 2021 - Volunteer survey completed
- 279 nests in 2021 (vs 92 in 2014) - level of effort, definition of active?





Eagle and Osprey Nesting

STATUS - VERY GOOD

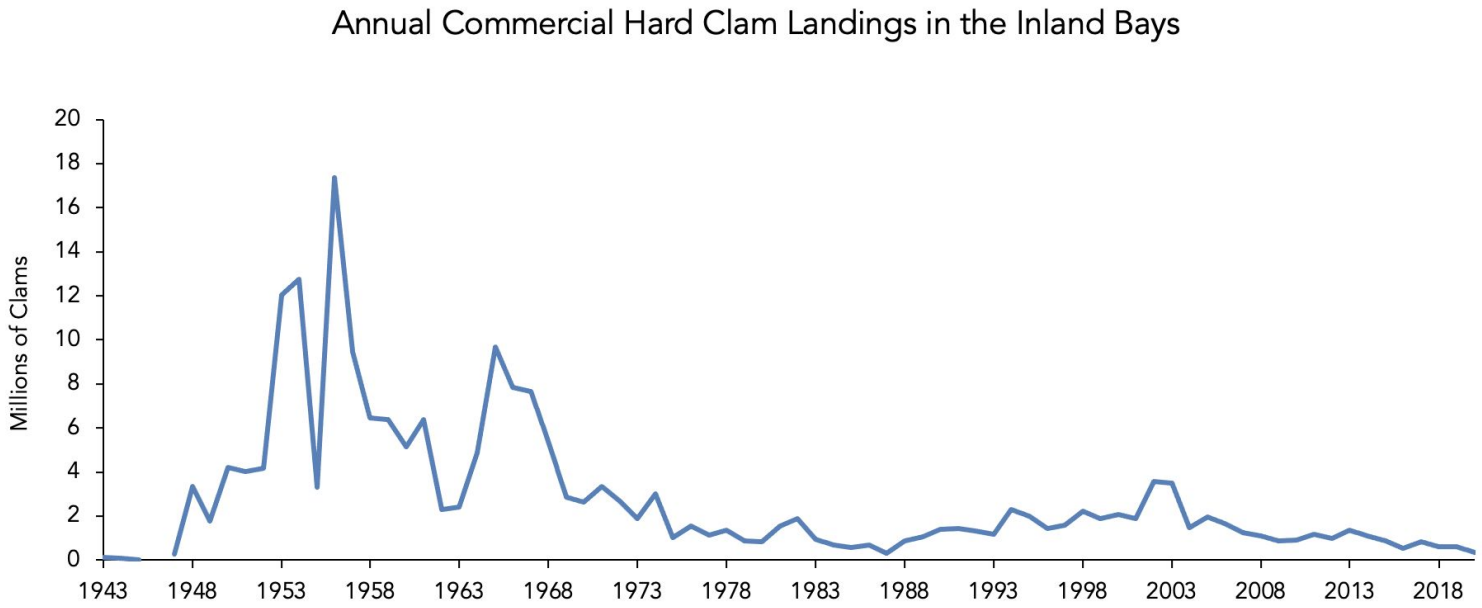
- Stable or increasing breeding populations of both Bald Eagles and Ospreys
- Both species now seen commonly around the Bays

TREND - IMPROVING

- **LT** - Active nests have increased over time, with significant trend upward since early 2000's
- **ST** - Active osprey nests increased; but change in survey protocol makes comparison challenging; No trend in eagle nests

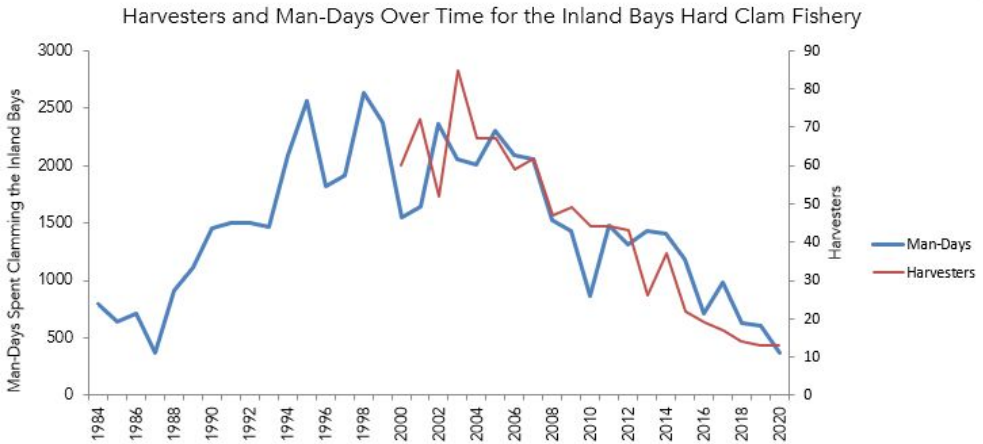
Commercial Clam Harvests

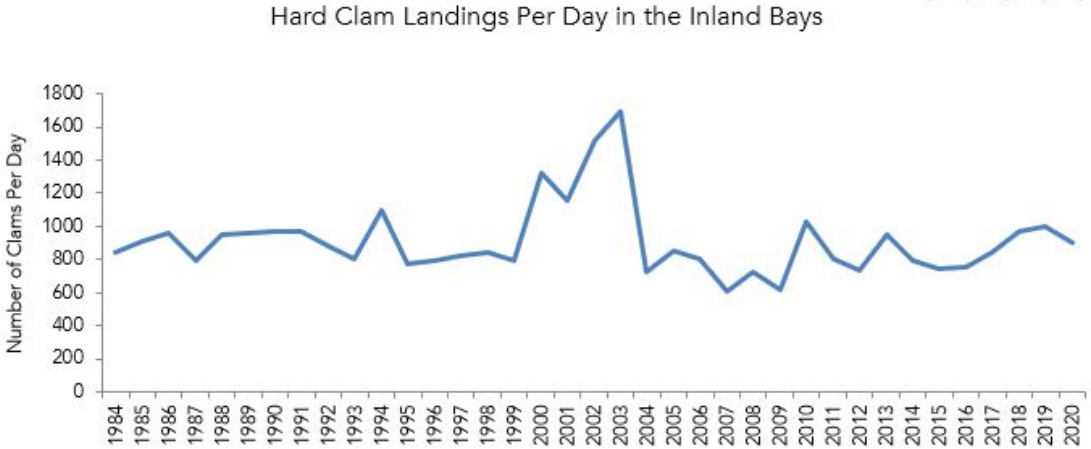
- Hard clams harvested by both recreational and commercial clammers
- Like oysters, clams improve water clarity via filtration



Commercial Clam Harvests

- Low numbers reflect the state of the fishery, not the state of the clam population
- Fewer harvesters
- Different fishing methods
- Catch per unit effort varies among harvesters





Commercial Clam Landings

STATUS - FAIR

- Current numbers close to historic low, but landings per day stable
- Reflects low numbers of harvesters and clamming methods

TREND - NO TREND

- **LT** - landings per day have been relatively stable, harvesters declining
- **ST** - landings per day similar to last reporting period

Shellfish Farming - new indicator

Annual statistics on commercial shellfish farming in the Inland Bays

Year	Total Lessees[1]	Total Acres Leased[1]		No. Shellfish Planted		No. Shellfish Harvested	
		Oysters	Clams	Oysters	Clams[2]	Oysters	Clams[2]
2018[2]	-	-	-	-	-	-	-
2019[3]	10	43	5	1,453,951	-	111,652	-
2020[3]	13	37	5	727,000	-	184,033[4]	-

[1] The CIB leased one acre for scientific research. Only commercial leases are included in these statistics.

[2] Data confidential and not reported due to fewer than three growers.

[3] August through December harvest data only. No data available for January to July, due to DNREC's "rule of three" confidentiality in reporting, and fewer than three growers reported harvest these months.

[4] Does not include the 75,000 oysters purchased by Delaware Sea Grant.

Shellfish Farming

Estimates of total nitrogen and phosphorus, incorporated in tissue, removed from the Inland Bays through harvest of farmed oysters (Chesapeake Bay protocol)

Year	Size Class Midpoint (inches)	Total Oysters Harvested	Content in Tissue, Default Value (g/oyster)[2]		Total Nutrient Content Removed Annually (g)		Total Nutrients Removed, All Classes	
			TN	TP	TN	TP	TN	TP
2019	3”	49,127	0.13	0.01	6,387	491	23,447 g (51.7 lb)	2,456 g (5.4 lb)
	4”	58,059	0.26	0.03	15,095	1,742		
	5”	4,466	0.44	0.05	1,965	223		
2020[1]	3”	113,440	0.13	0.01	14,747	1,134	54,142 g (119.4 lb)	5,672 g (12.5 lb)
	4”	134,065	0.26	0.03	34,857	4,022		
	5”	10,313	0.44	0.05	4,538	516		
Total All Years	--	**369,470**	--	--	--	--	**77,589 g (171.0 lb)**	**8,128 g (18.0 lb)**

[1] Includes oysters purchased by Delaware Sea Grant that were moved to Delaware Bay.
[2] Default values for triploid oysters from Cornwell et al. (2016).

If all SADA’s are farmed at normal stocking rates, would translate to reductions:

- *4,630 lb TN*
- *485 lb TP*

Shellfish Farming

STATUS - GOOD

- Aquaculture leases are being farmed, numbers still low

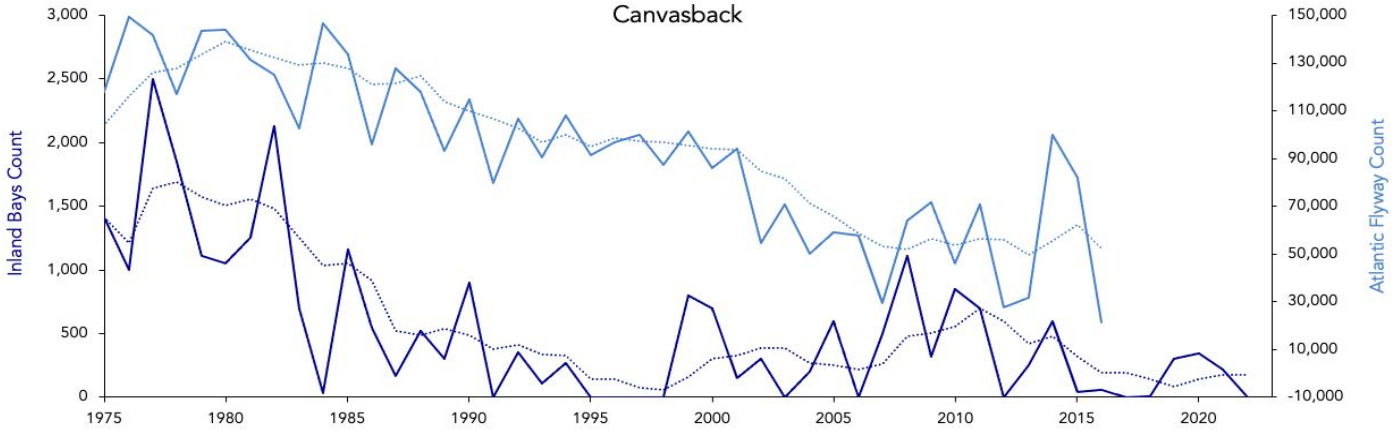
TREND - LIKELY IMPROVING

- **LT** - N/A
- **ST** - No stats yet for 2021. Slow increase in farming, demand is there. Hit hard by COVID.

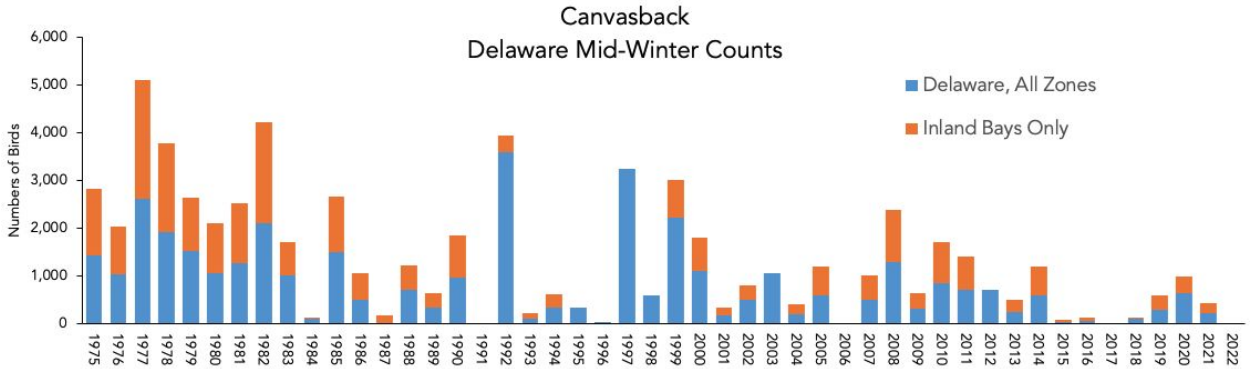
Winter Waterfowl Counts

- Three sensitive species used as indicators: CANV, ABDU, ATBR
- Mid-Winter Survey data (January) from DE compared with the Atlantic Flyway
- Comparisons help understand responses to changes in the Inland Bays

Canvasback

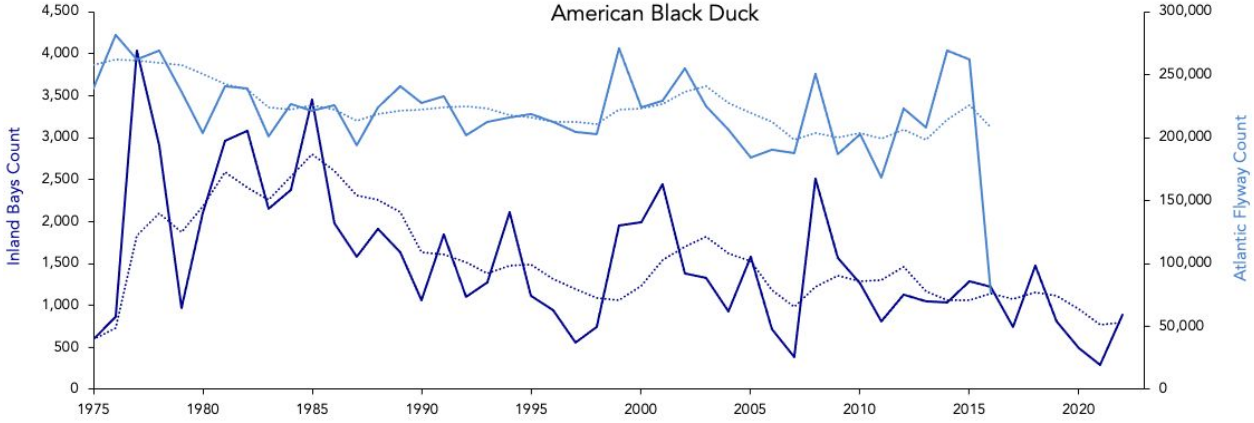


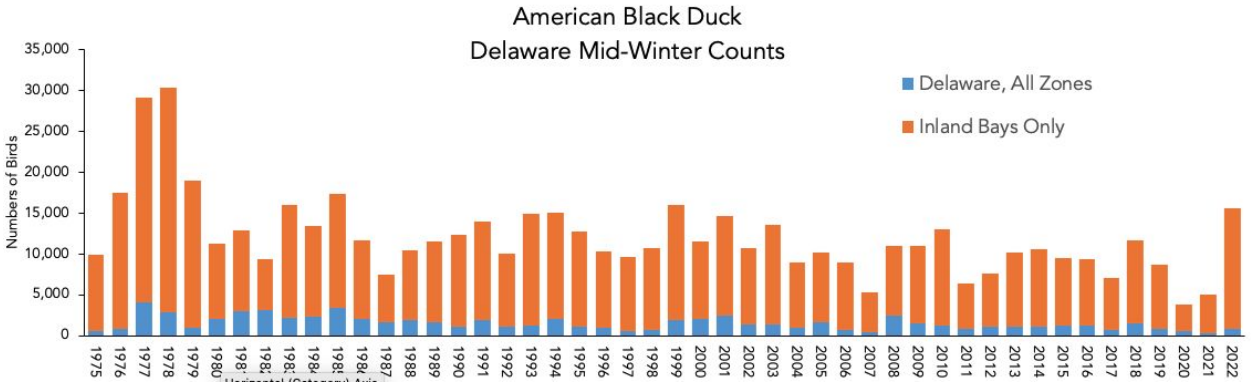
- Very low numbers (hundreds); downward LT trend
- Most DE CANV counted are in the Inland Bays, mostly Silver Lake
- No significant change since 2016 (needs testing)



American Black Duck

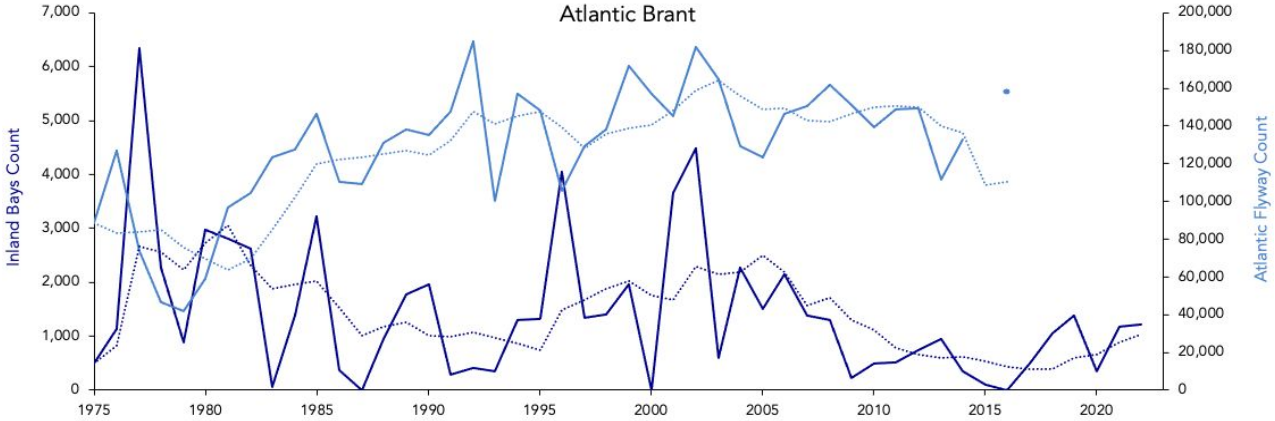
- IB has both year-round and migratory pops of ABDU
- Sharp Atl. Flyway decreases mid-century (loss of marsh habitat, hunting pressure, interbreeding w/ MALL)
- Numbers low but stable

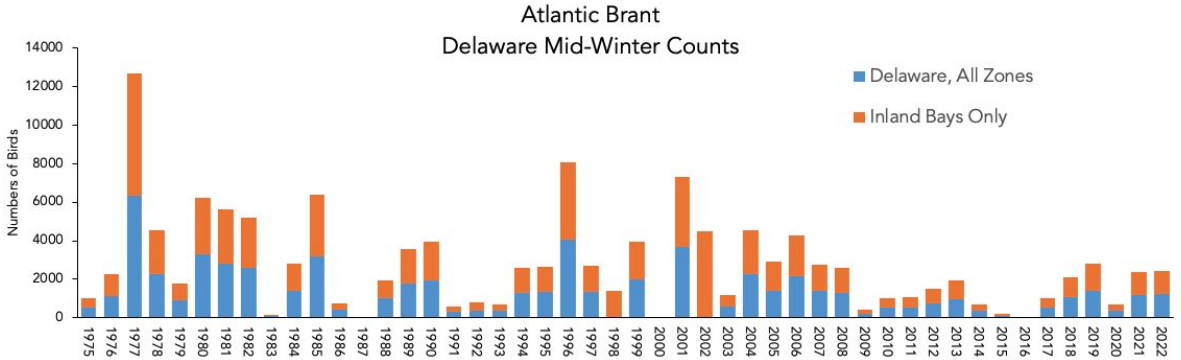




Atlantic Brant

- Pop. declines fo llowed declines in eelgrass; adaptation to other diets
- 80-90% of ATBR winter in NY/NJ; about half of DE pops are in the IB
- Atl. flyway pops stabilized
- IB pops declined, but maybe show a slight upturn since 2016





Winter Waterfowl Counts

STATUS - FAIR

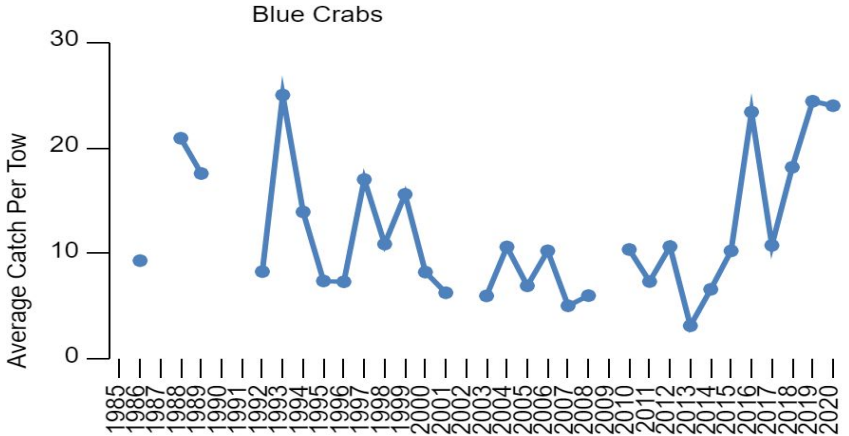
- Numbers lower than historically but currently stable

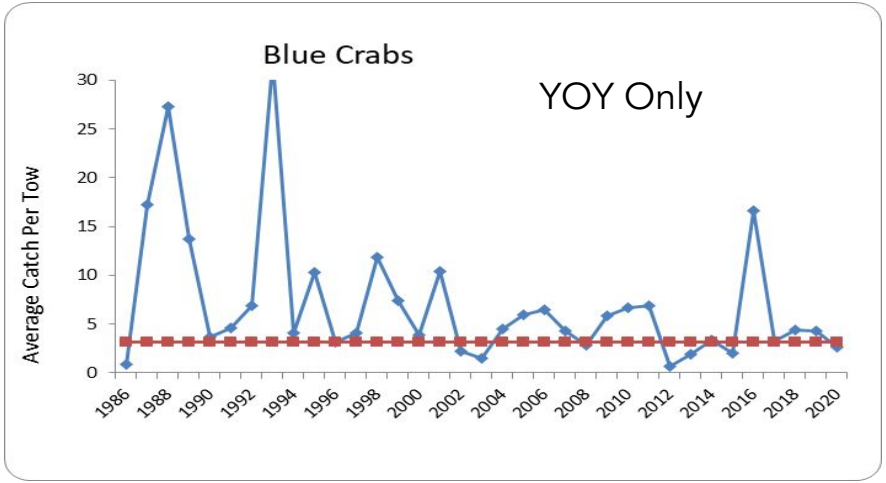
TREND - NO TREND

- **LT** - declines in all three species
- **ST** - no significant change since 2016

Blue Crab Abundance

- Large interannual variation typical
- No commercial harvest in the IB
- Popular recreational fishery, but no data on catch
- Trawl survey data: Past few years - average or below average recruitment, but good overall abundance (good survivorship?)
- STAC suggestion - YOY might be more meaningful indicator





Blue Crab Abundance

STATUS - FAIR

- Abundance increased over last five years, with average recruitment
- WQ problems in some nursery areas

TREND - IMPROVING

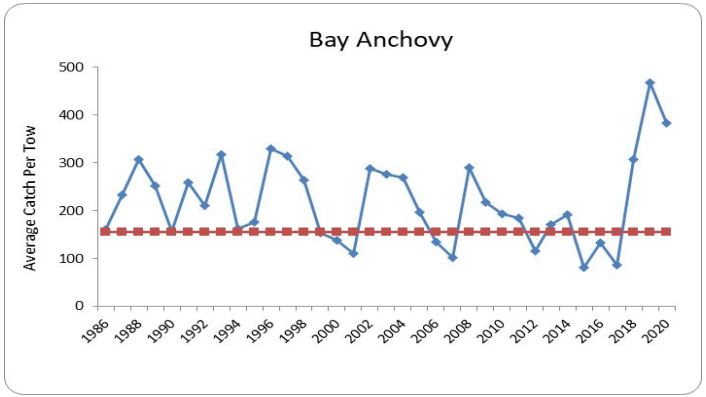
- **LT** - No apparent LT trend in mean catch per tow
- **ST** - Average recruitment but good overall abundance

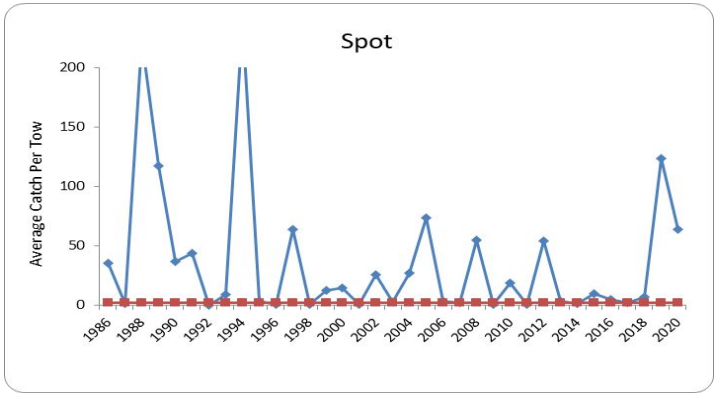
Fish Abundance

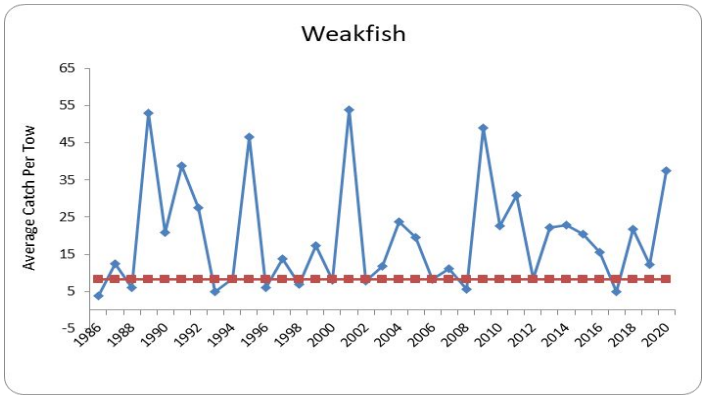
- Marine fisheries species typically have large interannual, with pulses of good recruitment mixed with years of low recruitment
- Changes in abundance driven by many different factors (external - ocean currents, weather patterns, food availability; internal - land use, habitat changes

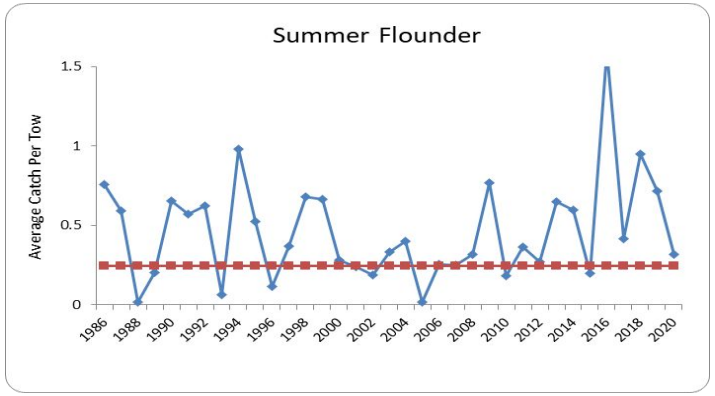
Fish Abundance

- Four indicator species used
- Had good recruitment pulses during this report period









Fish Abundance

STATUS - FAIR to GOOD

- Most trawl species have had above average recruitment years recently

TREND - IMPROVING

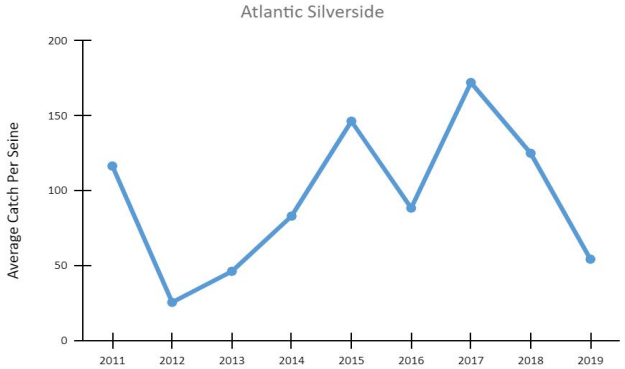
- **LT** - No long term trends apparent
- **ST** - Last five years, many species had strong recruitment years

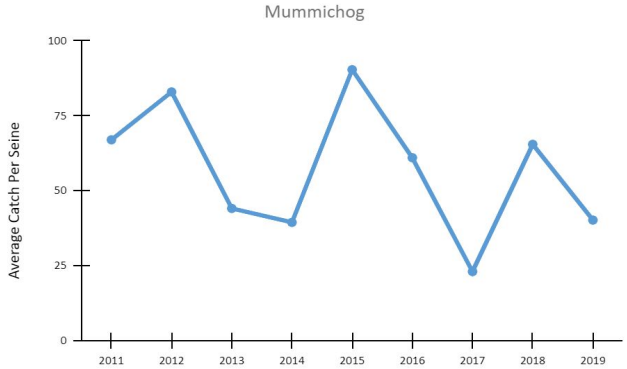
Shorezone Fish - new indicator

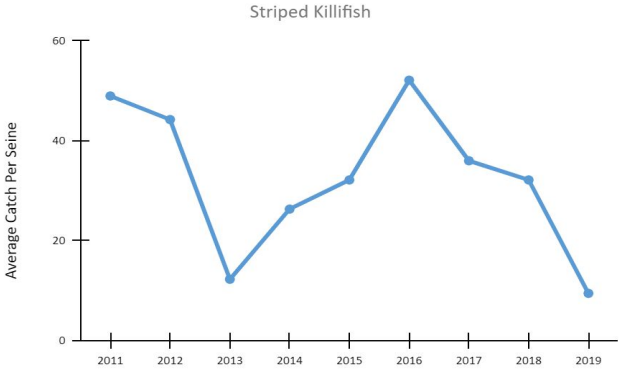
- Nearshore an important nursery area for YOY of many spp. and many important forage spp.
- Inland Bays shorezone dominated by four species: Mummichog,
  Atl. Silverside, Sheepshead Minnow, Striped Killifish
- Now have 10 years of data

Shorezone Fish - new indicator

- Last ten years Mummichog and Sheepshead Minnow have declined
- Possibly due to increased predator abundances or habitat changes due to shoreline hardening and marsh deterioration







Shorezone Fish

STATUS - FAIR?

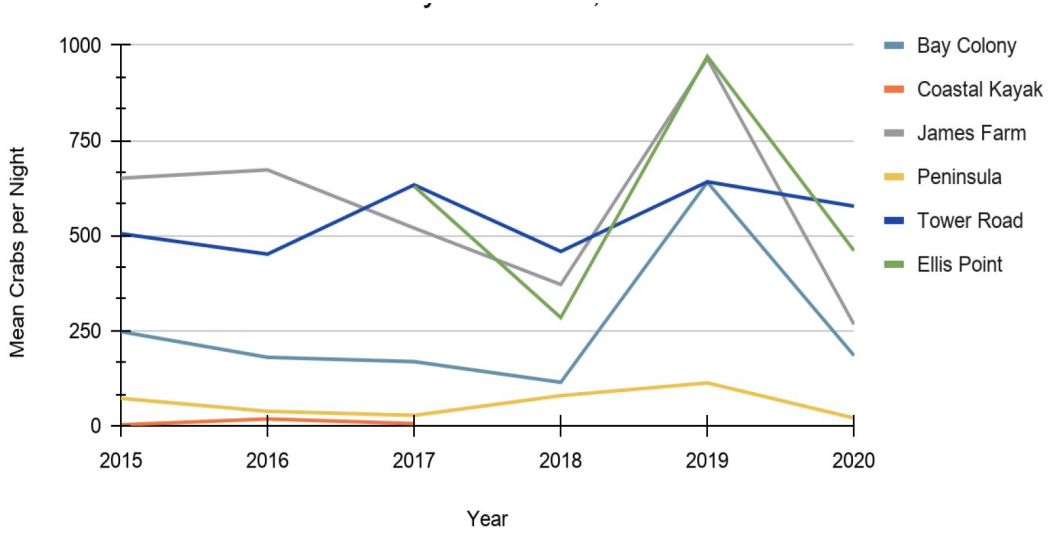
- Uncertain how to set this

TREND - DEGRADING

- **LT -** Mummichog and Sheepshead Minnow significantly declining
- **ST** - Declining or no trend?

Horseshoe Crab Spawning - new indicator

- Annual volunteer survey data
- Keystone species - supports not only Red Knots, but many other parts of ecosystem
- Tagging: IB HSCs important component of regional DE Bay population
- Spawning densities in IB comparable to DE Bay



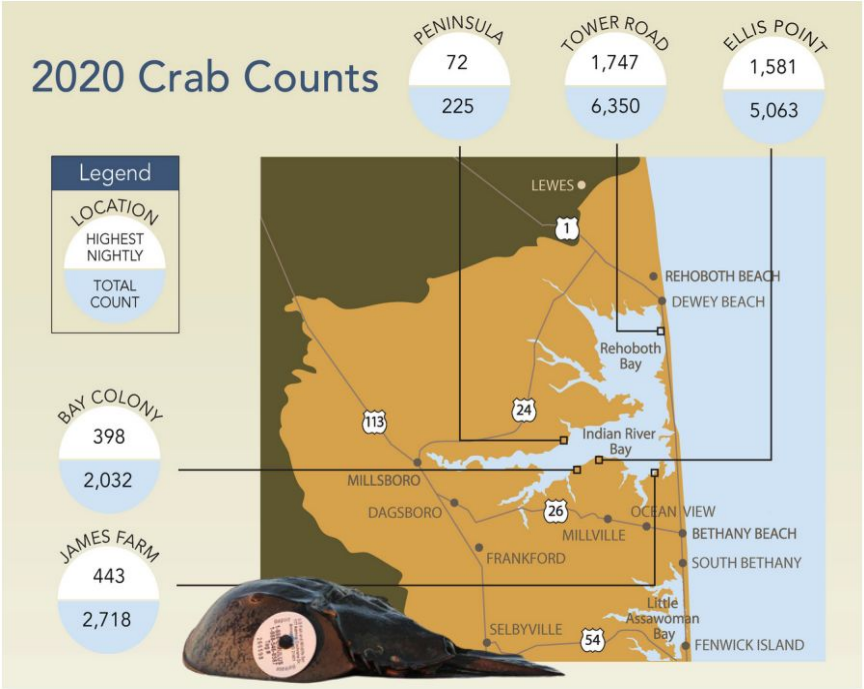
Horseshoe Crab Spawning

STATUS - FAIR

- Loss of sandy beaches

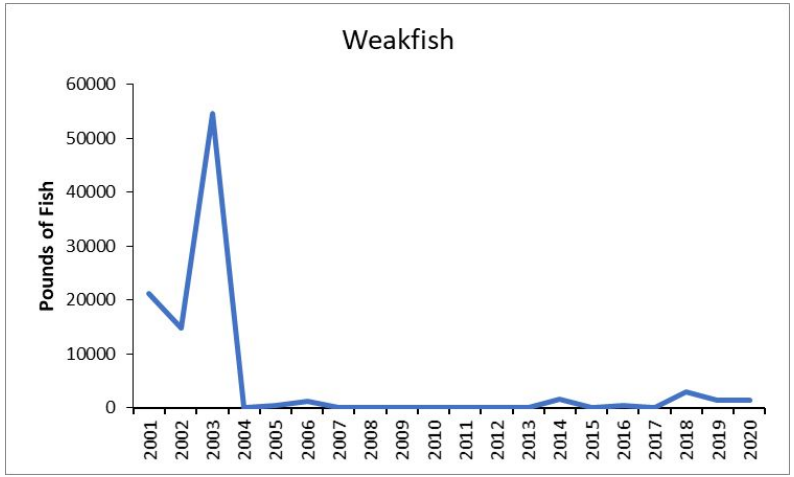
TREND - NO TREND

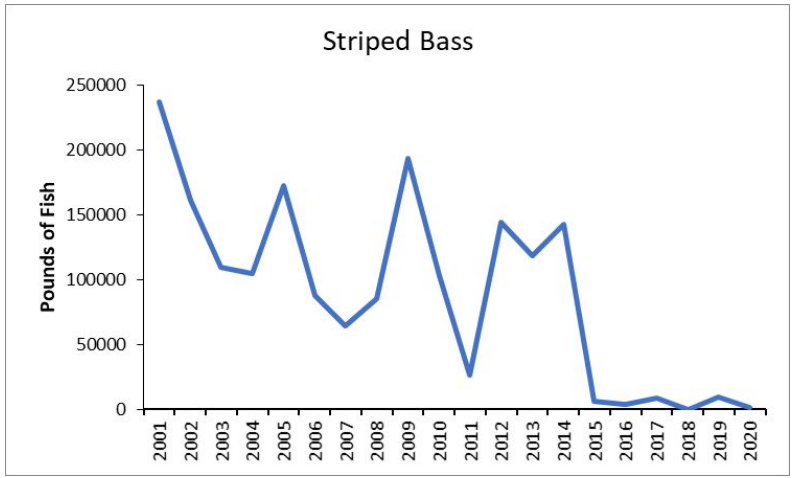
- **LT -** Numbers stable, but remain far below historic levels
- **ST** - no trend

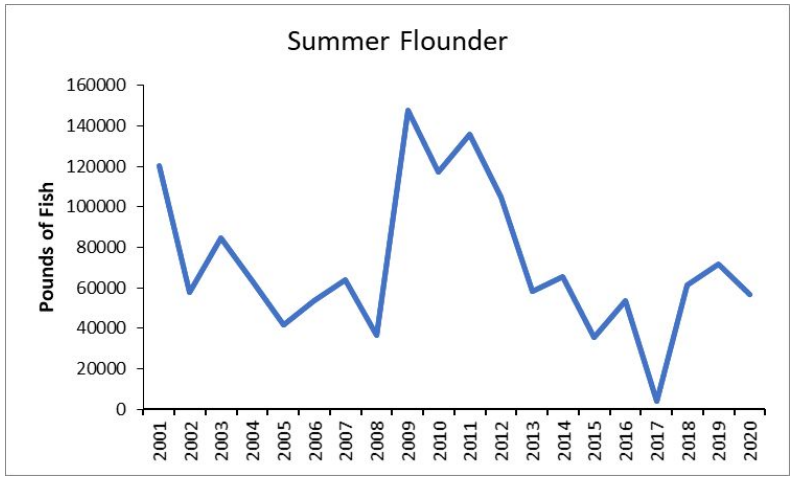


Recreational Fishing Statistics

- Major drop in Striped Bass harvest
- Continued minimal harvest of Weakfish
- Typical harvest of Summer Flounder
- No estimates available for no. of trips or overall pounds caught







Recreational Fishing Statistics - Summary

STATUS - FAIR

- Harvest lower than expected (especially considering above average recruitment for Weakfish and Summer Flounder)

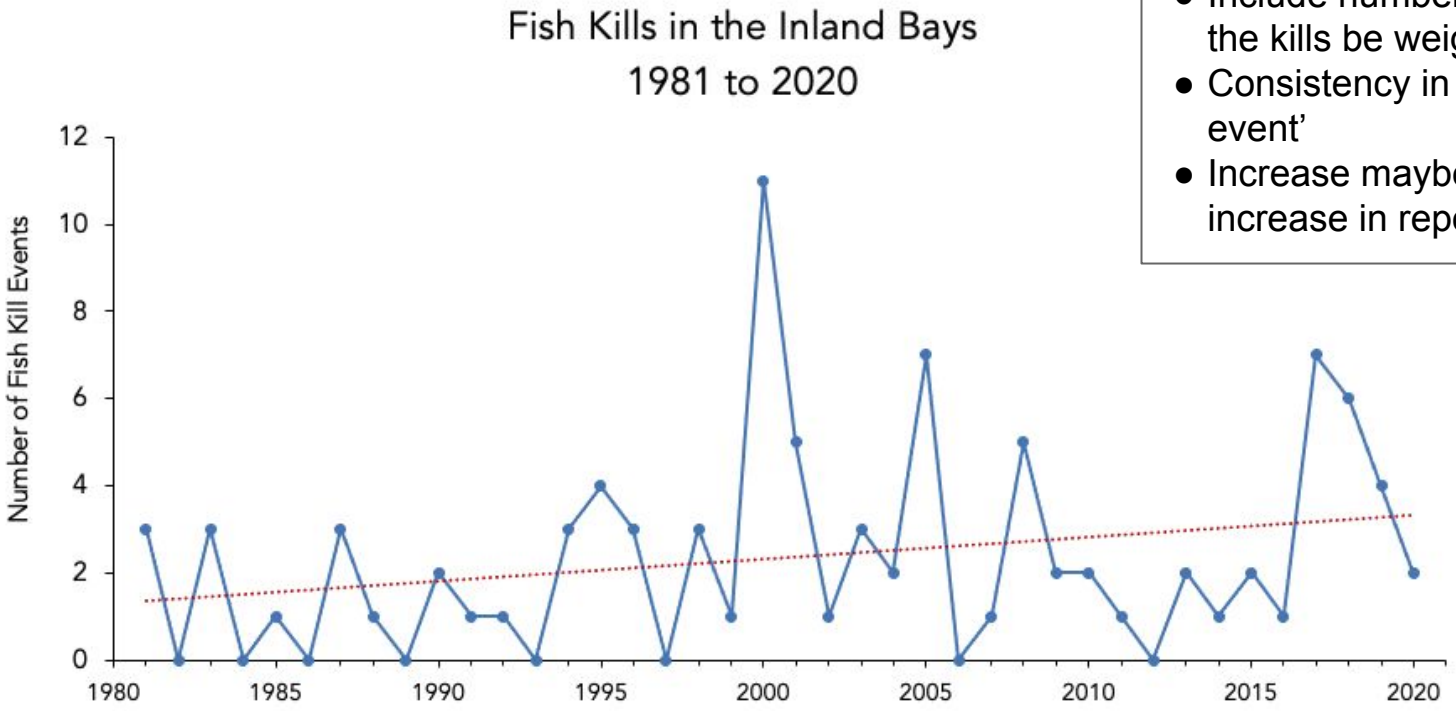
TREND - DEGRADING

- **LT** - Weakfish and Striped Bass harvests show clear long-term declines
- **ST** - Striped Bass show major drop off

Number of Fish Kills

- Indicator of stress in bay environment, usually caused by a combination of nutrient pollution and/or weather conditions
- Most kills happen in summer when algae are abundant, high temperatures, low DO
- Majority of kills reported in the Bays involve Atlantic Menhaden

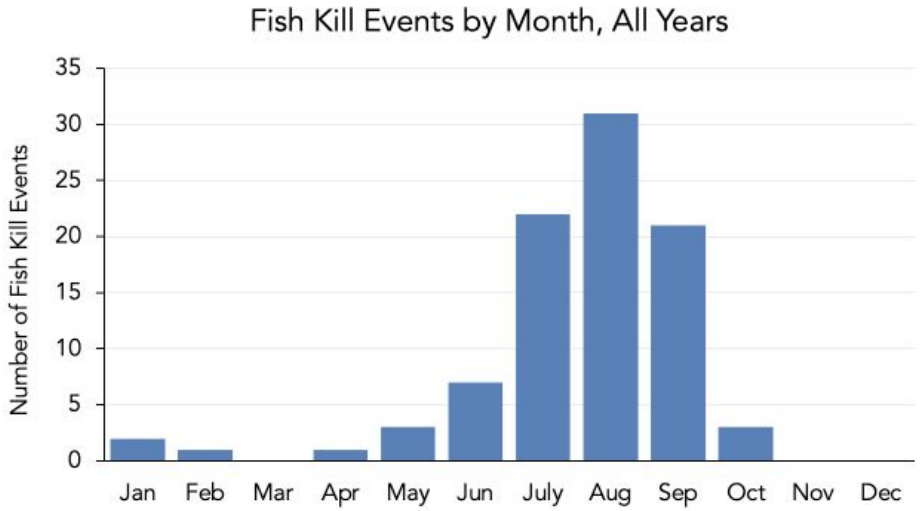
Number of Fish Kills

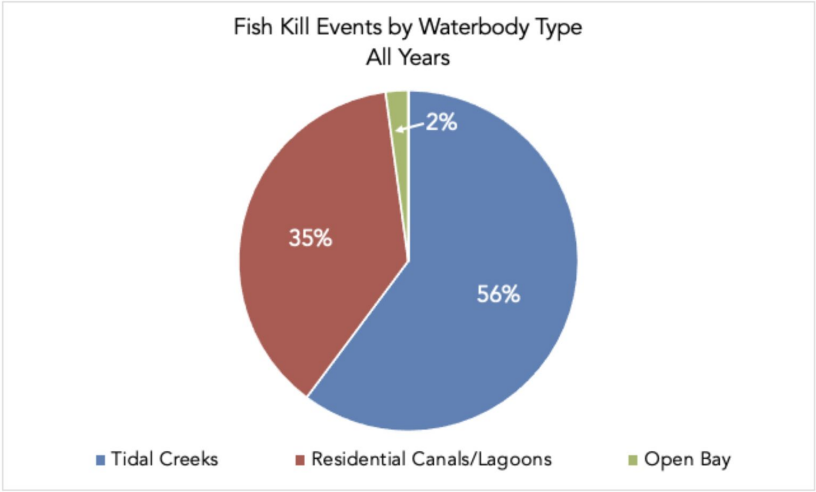


STAC Review:

- Include number of fish/kill; can the kills be weighted?
- Consistency in defining ‘an event’
- Increase maybe related to increase in reporting?

Number of Fish Kills





Number of Fish Kills - Summary

STATUS - POOR to FAIR

- 2021 had high no. of fish kills - will be added to plot

TREND - Possibly DEGRADING?

- LT - number of kills reported varies greatly from year to year
- ST - Increase in reported kills; possibly due to degrading WQ, or other factors

Overall Status and Trends - Living Resources, 2016

Eagles and ospreys are commonly seen around the Bays. Clams and some fish populations are stable. Other species such as Blue Crabs and waterfowl have declined. Oysters and bay grasses are rare in the Bays.

Overall Status and Trends - Living Resources, 2021

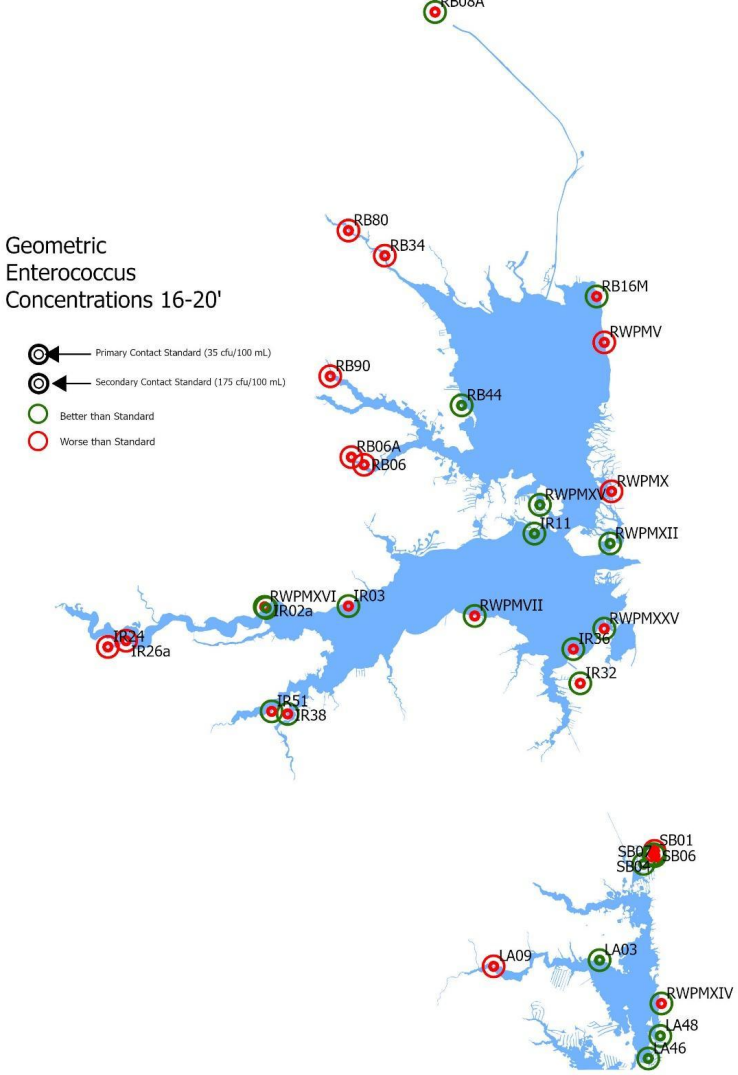
Indicator	Status	(ST) Trend
Baygrasses	Very Poor	Slightly Improving
Eagle/Osprey Nesting	Very Good	Improving
Hard Clam Landings	Poor	No Trend
Shellfish Farming	Fair	Improving
Winter Waterfowl Counts	Fair	No Trend
Blue Crab Abundance	Fair	Improving
Fish Abundance	Fair to Good	Improving
Shorezone Fish	Fair	Degrading
Recreational Fishing	Poor	No Trend
HSC Spawning	Fair	No trend
No. of Fish Kills	Poor	Possibly Degrading?

(Weighted toward fish indicators)

HUMAN HEALTH RISKS

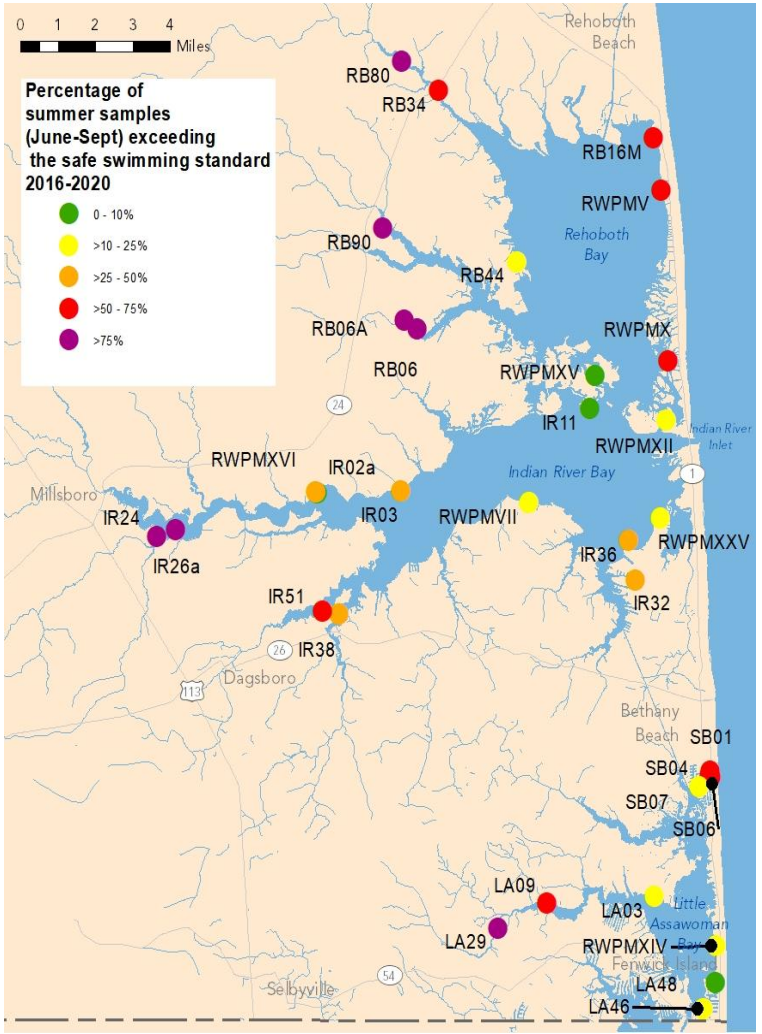
Fecal Indicator Bacteria

- Many trib sites routinely fail primary contact standard (for swimming)
- Most areas of the Bays do routinely meet secondary contact standard (for uses like kayaking)
- Sources of *Enterococcus* can be wildlife, don't necessarily indicate human source; distinguishing between sources not done at baywide scale.
- Monitoring sites shore-based; bacteria tend to be higher than even a few hundred meters into the water; therefore may not be representative of open waters in some areas.



Fecal Indicator Bacteria

- Multiple stations have failed the primary contact standard more often than previously reported in the 2016 report (RB80, RB16M, RB44, IR36, LA03).
- New stations have come online close to former stations and are reporting worse % failing than the older stations (RWPMV, RWPMVII, IR51, IR03).
- Only improvements in % groups appears in LAB (LA09, Fenwick Island)
- Two stations RB06a and RB34 also have significantly worsening trends.



Fecal Indicator Bacteria

STATUS

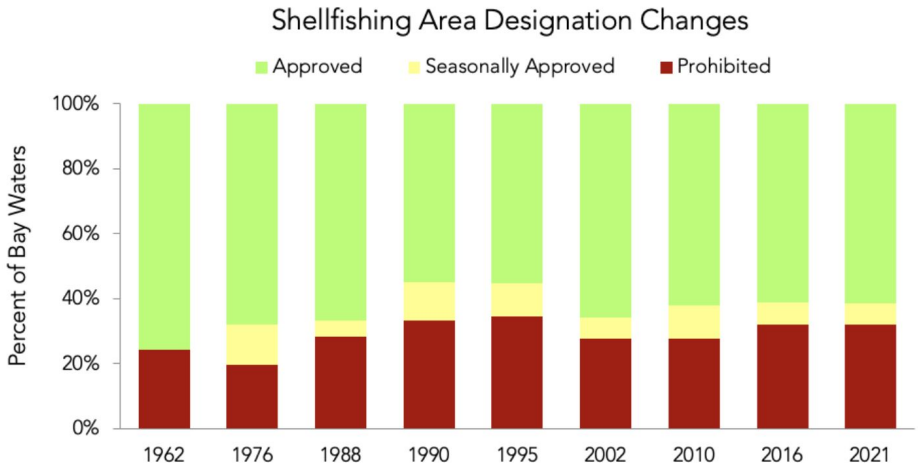
- Canals/tributaries remain above recommended swimming standards, though some meet secondary standards.
- Open waters largely met swimming standard most of the time last reporting period. 2016-2020, many sites failed >25% of the time, and not meeting primary contact std over LT (but largely meeting secondary contact std)

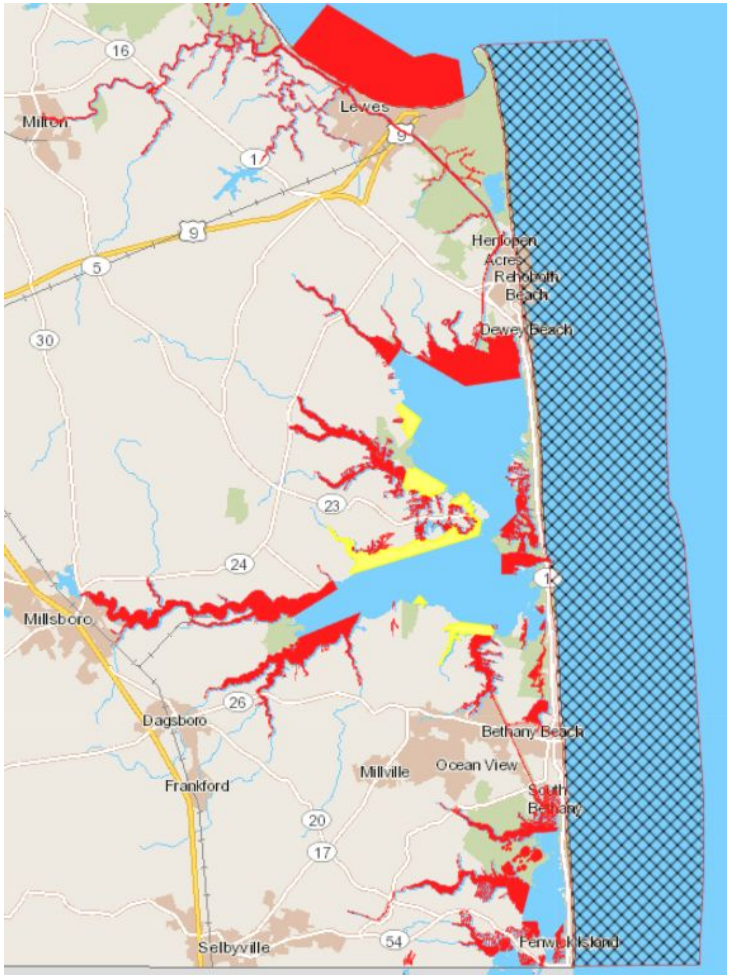
TREND

- **LT** - Trend site specific; RB06a and RB34 degrading
- **ST** - Fewer sites meet standard than in previous report
- *STAC review note: Some changes may reflect changes in sampling effort*

Approved Shellfish Growing Waters

- Classification based primarily on proximity to potential pollution sources
- High fecal bacteria may result in add'l temporary closures
- Only change, config. Of marina closure in Beach Cove 2016; no change in acreage





Approved Shellfish Growing Waters

STATUS - FAIR

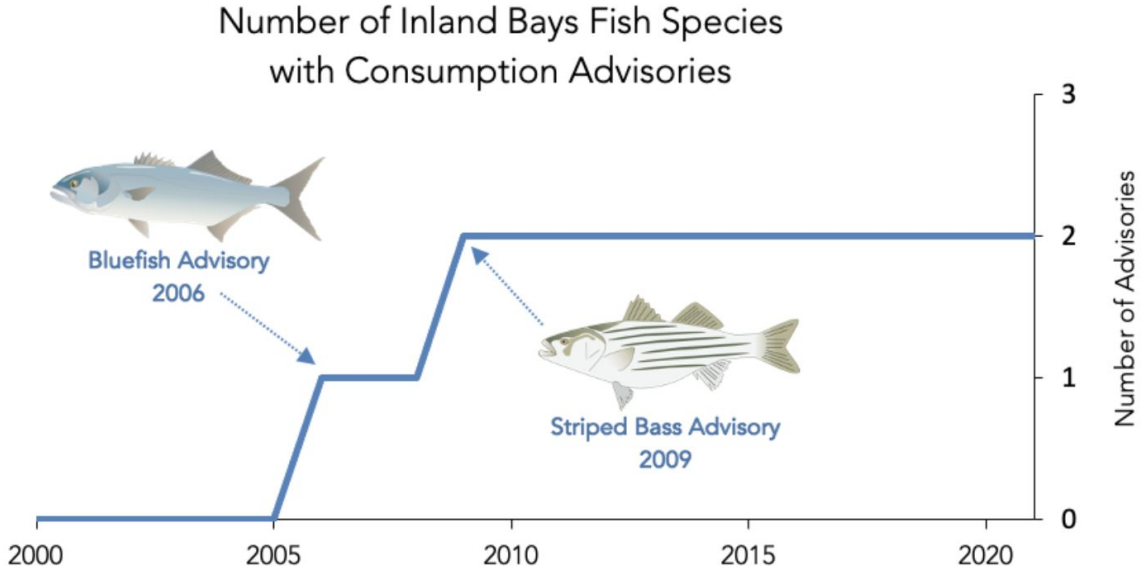
- 61% approved, 7% seasonally approved, 32% prohibited
- Rehoboth outfall removed from canal, but unlikely to change approved area

TREND - NO TREND

- LT - Some fluctuations, no real trend
- ST - no change since 2016

Fish Consumption Advisories

- Continuing advisories for Bluefish & Striped Bass
- Both are migratory, pick up these contaminants outside of the Inland Bays
- Indicator of PCB and Hg levels in Delaware waterways as a whole, rather than in the Inland Bays specifically.



Fish Consumption Advisories - Summary

STATUS - FAIR

- Advisories currently for Bluefish and Striped Bass

TREND - NO TREND

- LT - Some advisories are being lifted statewide due to lower PCBs and Hg
- ST - no change in IB advisories since 2016

OUTLOOK

- Potential future advisories for PFAS?
- Call-out box on emerging contaminants

Overall Status and Trend - Human Health Risks, 2016

Most tributaries and canals are unsafe for swimming or for the harvest of shellfish. Consumption advisories for Striped Bass and Bluefish caught in the Bays remain in effect.

Overall Status and Trend - Human Health Risks, 2021

Indicator		Status	Trend
Fecal Bacteria		Fair	Degrading or no trend
Approved Shellfish Waters		Fair	No trend
Fish Consumption Advisories		Fair	No trend

CLIMATE

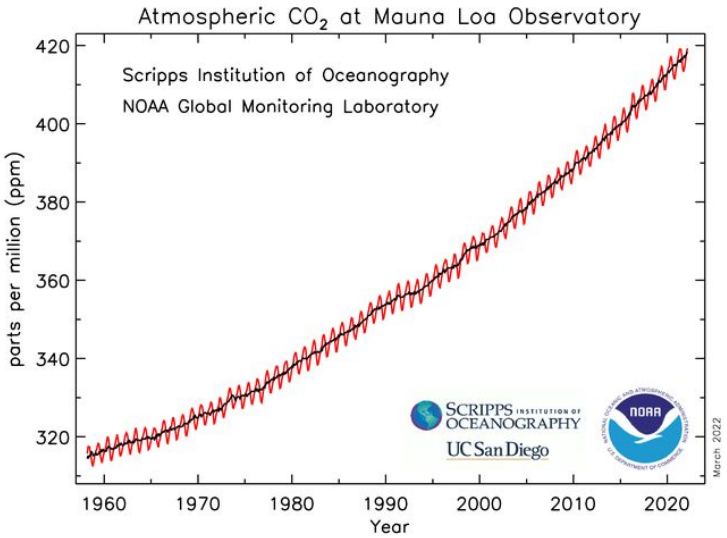
Atmospheric CO_2 Concentration

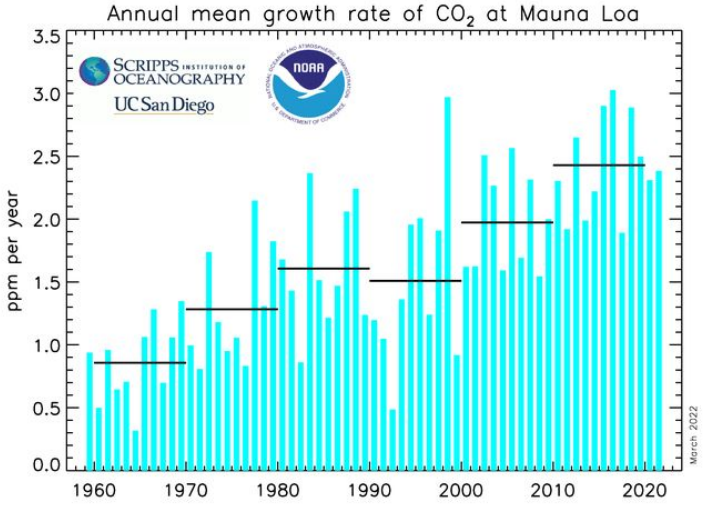
STATUS - POOR

- Monthly average concentration 418.81 ppm in March 2022
- Preindustrial value 280 ppm

TREND - DEGRADING

- **LT** - Increased 101 ppm (32%) since 1960; rate of growth accelerating
- **ST** - Increased ~14 ppm since 2016





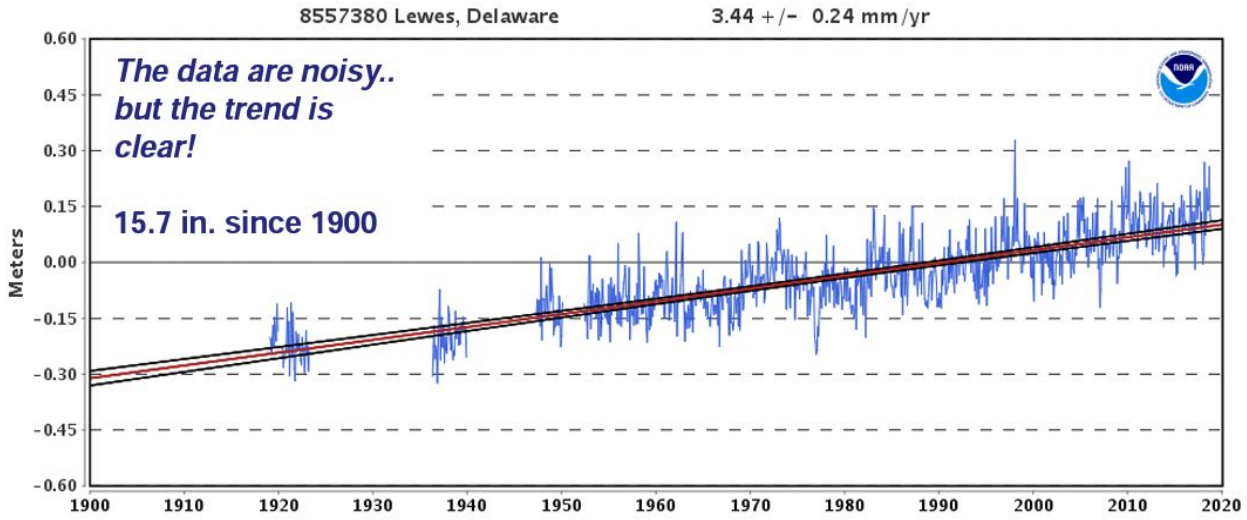
Sea Level Rise

STATUS - POOR

- Already leading to nuisance flooding; more vulnerable when hit by big storms

TREND - DEGRADING

- **LT** - 15.7 in increase since 1900
- **ST** - Continued trend



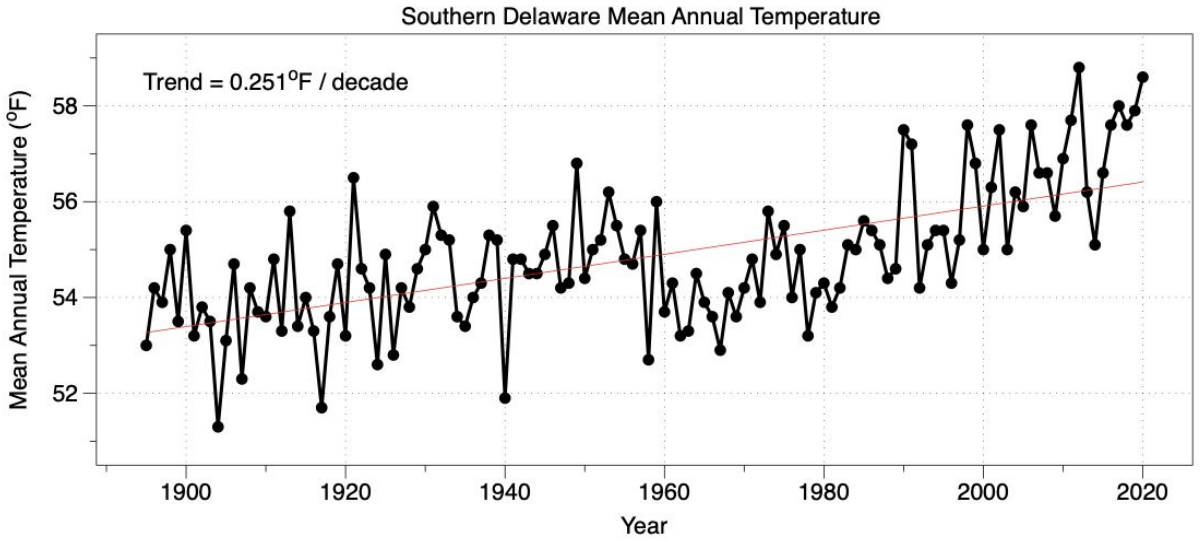
Air Temperature - Southern Delaware

STATUS - FAIR to POOR

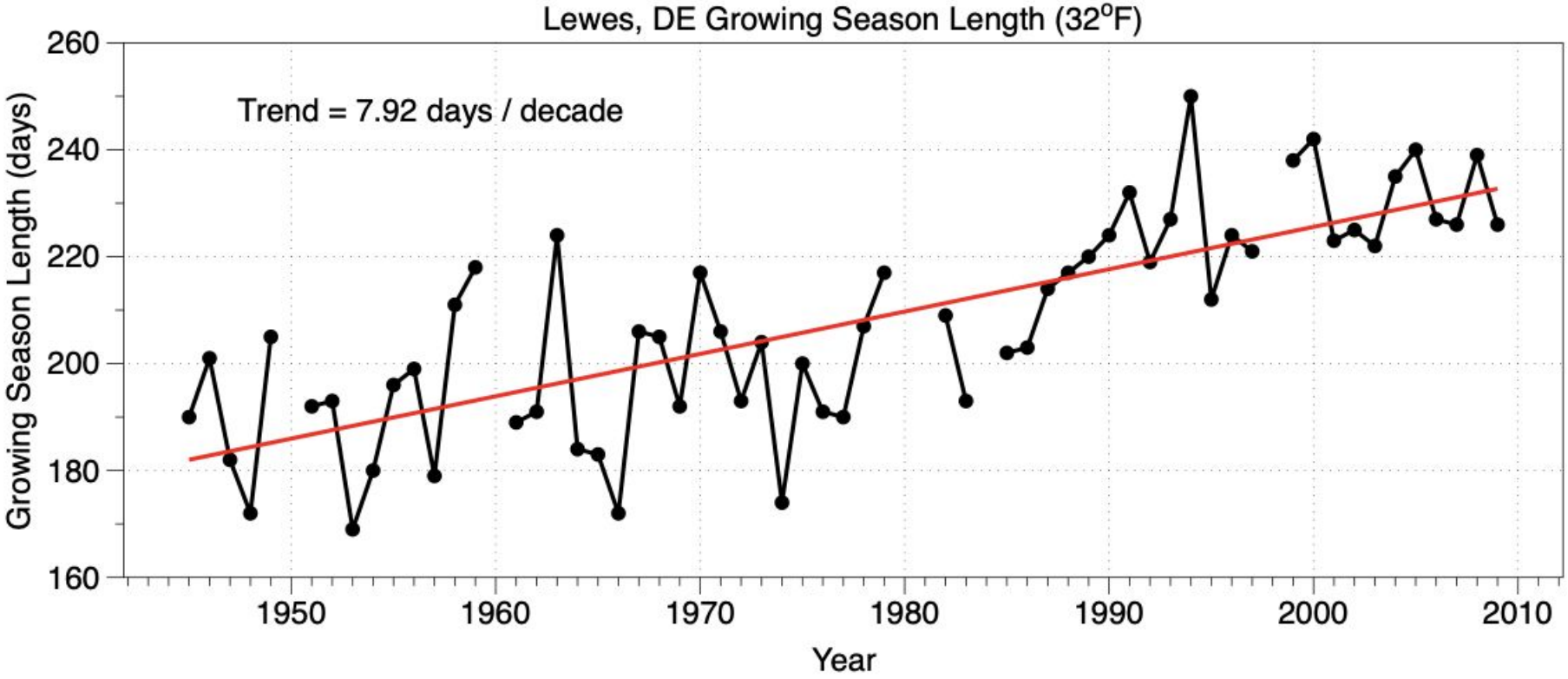
- 3°F since late 1890s

TREND - DEGRADING

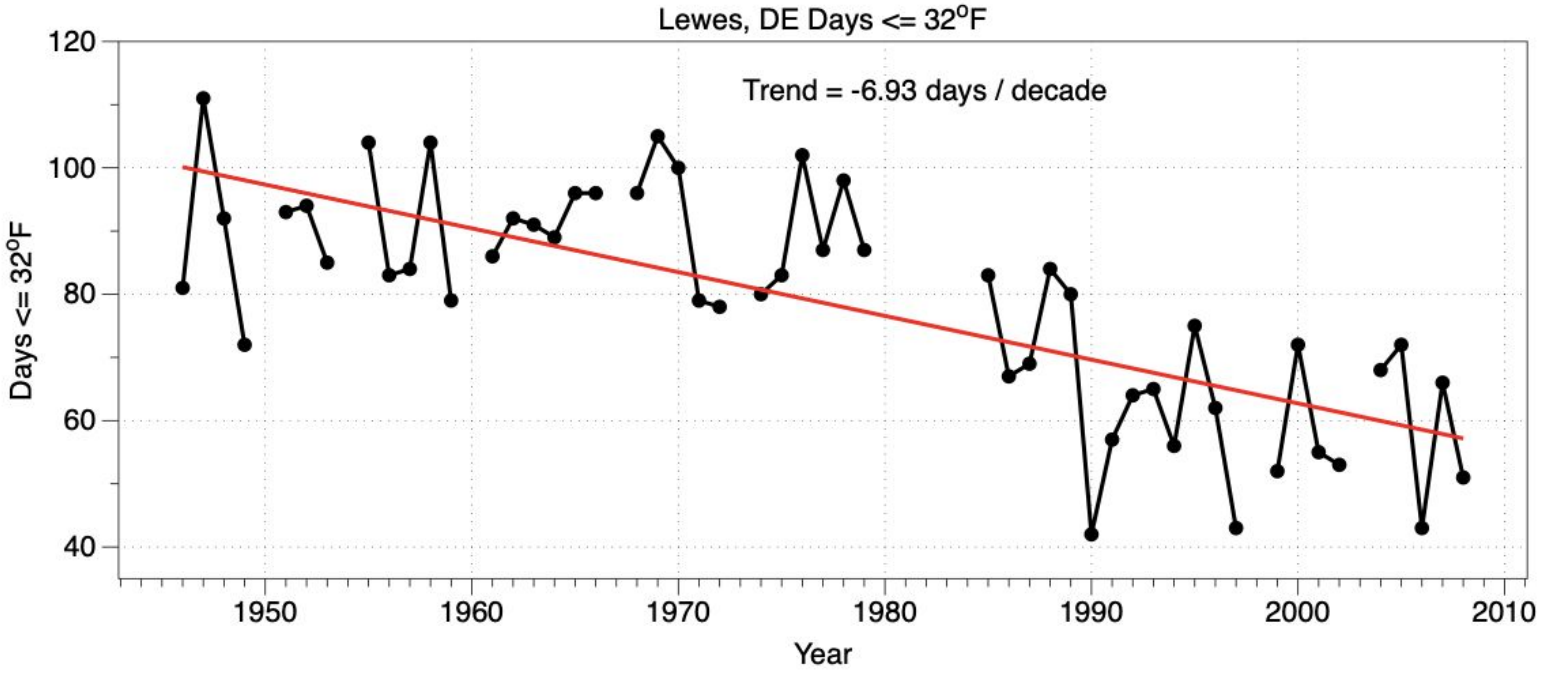
- **LT** - Increase of ~0.25°F/decade
- **ST** - Two highest recorded mean annual temps since 1895 occurred in the last ten years



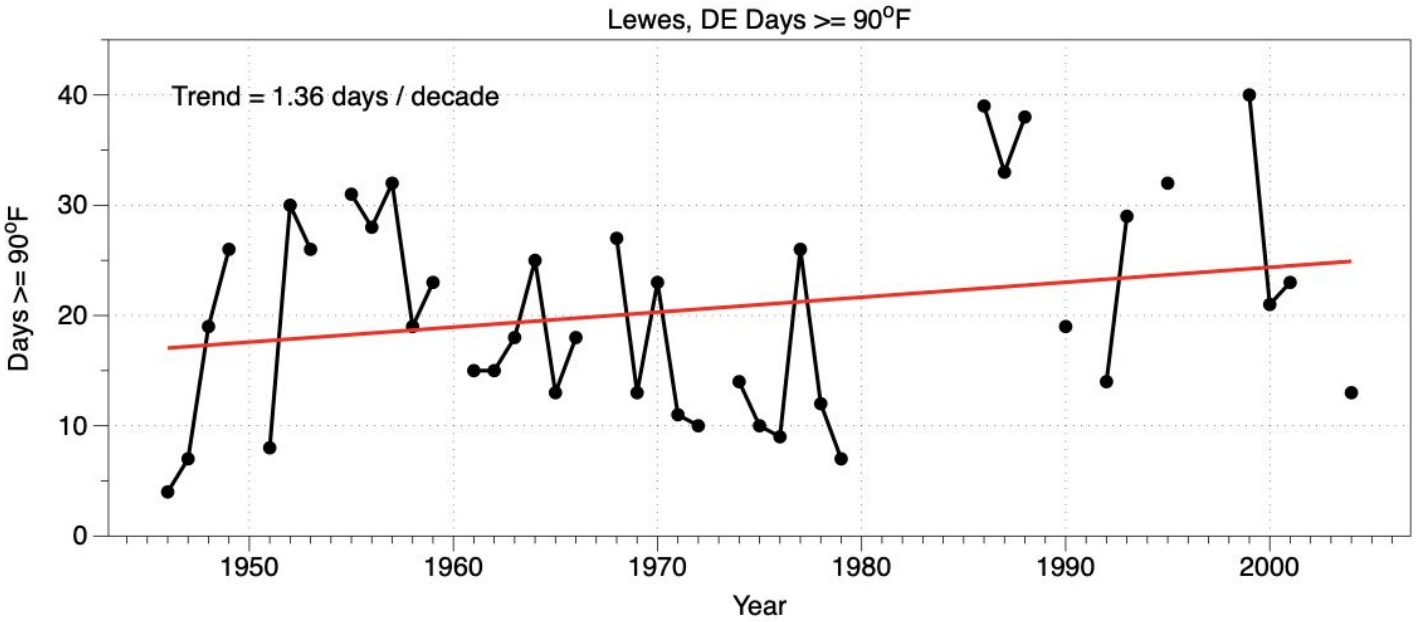
Growing Season Length



Annual Days Below Freezing



Annual Days Above 90 Degrees



- Increasing trend beginning ~1990s (DE Climate Projections Portal)
- Rate of increase modeled to increase through 2100

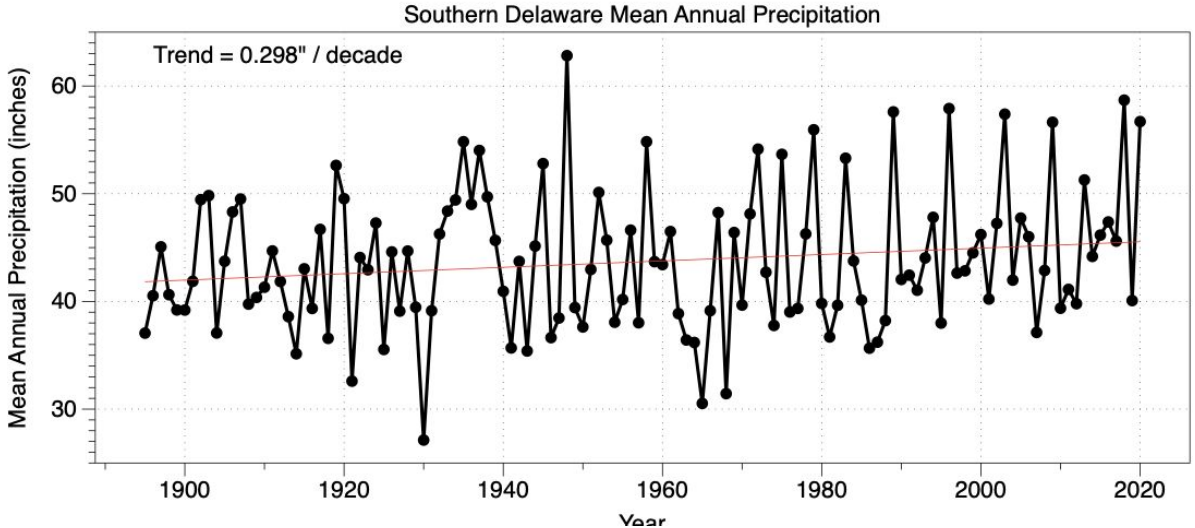
Annual Precipitation

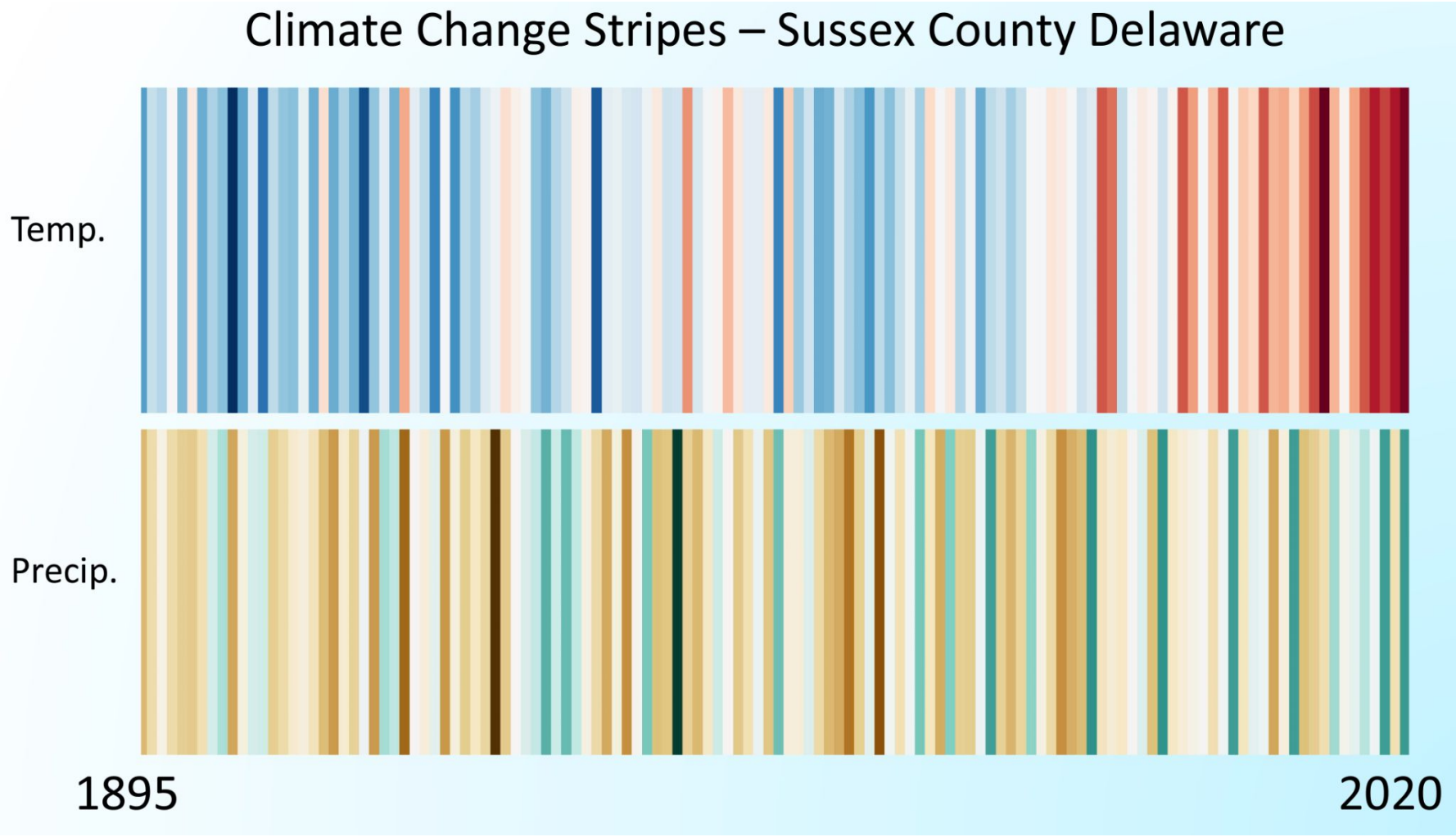
STATUS - FAIR

- ~3” increase in precipitation over 12 decades

TREND - DEGRADING

- **LT** - 0.262”/decade increase; large interannual variability
- **ST** -

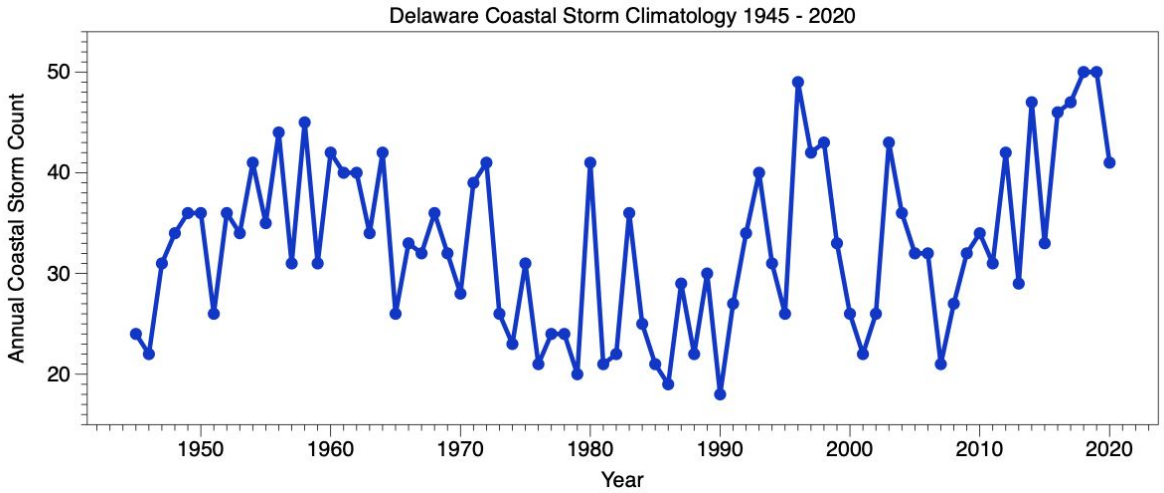



Climate Change Stripes – Sussex County Delaware
Temp.
Precip.
1895
2020

Coastal Storm Frequency

STATUS - FAIR?

- Coastal storms most common in March, least common in November.
- However, some of most damaging storms occur i n Autumn



TREND - NO TREND?

- **LT** - Frequency of coastal storms has varied greatly from year-to-year, with a minimum during the 1980s
- **ST** - Larger numbers during the last decade

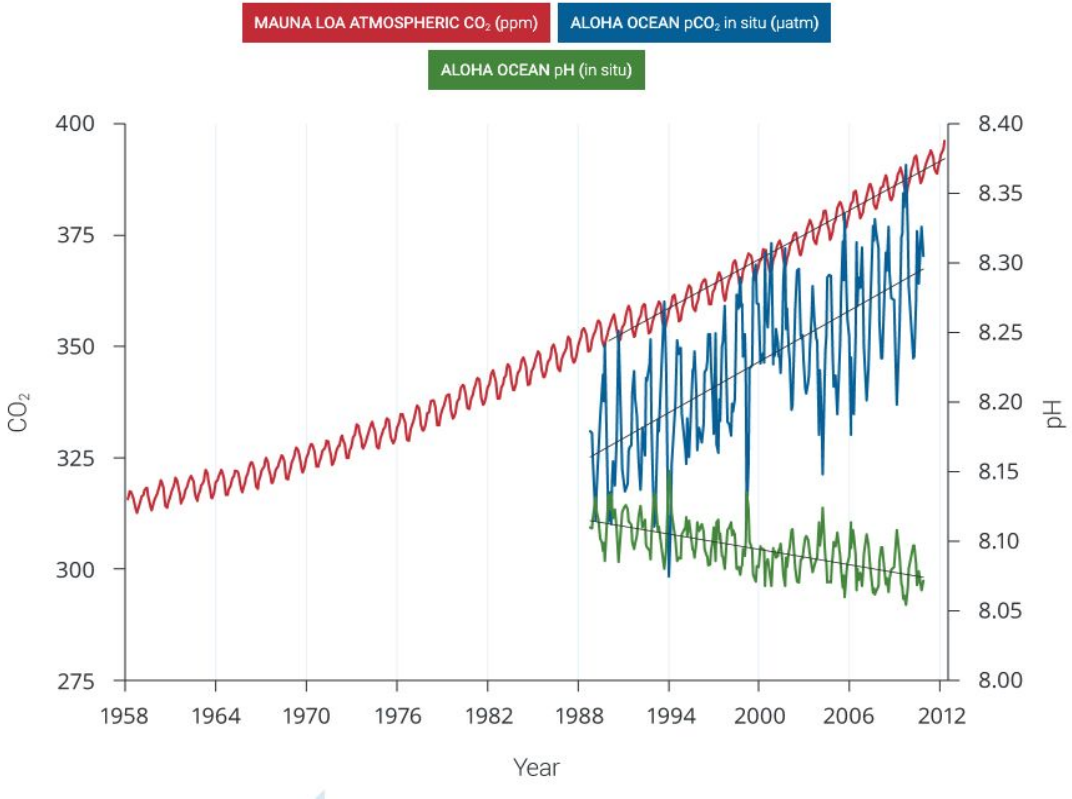
Ocean Acidification

STATUS - FAIR

- Oceans absorbing ~1/4 of the CO_2 emitted to atmosphere annually, becoming more acidic
- Concerns about intensifying impacts on marine and estuarine ecosystems

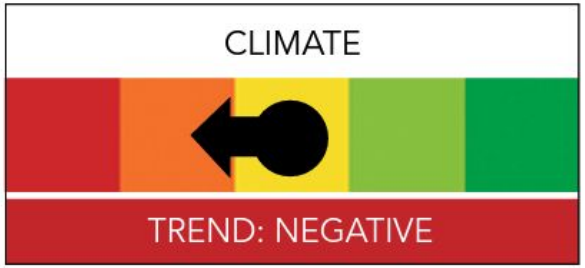
TREND - DEGRADING

- **LT** - Increase in oceanic CO_2 over last 17 years consistent with atmospheric increase
- **ST** - Increasing trend



Time series of atmospheric CO_2 at Mauna Loa (ppmv) and surface ocean pH and pCO_2 (µatm) at Ocean Station Aloha in the subtropical North Pacific Ocean.

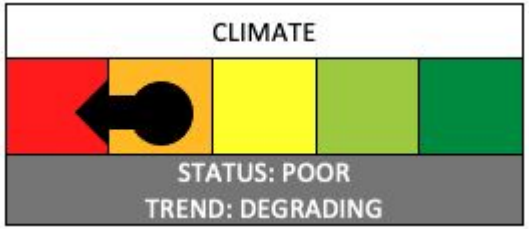
Overall Status and Trend - Climate, 2016



Sea level rise and warming temperatures are a growing challenge for watershed communities, residents and Bay ecosystems. Increased flooding and wetlands loss can be expected.

Overall Status and Trend - Climate, 2021

Indicator	Status	Trend (last 5 yrs)
Atmospheric CO_2 Conc.	Poor	Degrading
Mean Annual Air Temp	Poor	Degrading
Sea Level Rise	Poor	Degrading
Growing Season Length, Days Below Freezing, Days >90º	Fair to Poor	Degrading
Annual Precipitation	Fair	Degrading
Climatology	Fair to Poor	TBD
Ocean Acidification	Fair	Degrading



Next Steps

- Concurrence of STAC on indicator analyses, status, trends
  - *General agreement, understanding not everything is finalized*
  - *All comments will be placed on record and addressed*
  - *Tech reports/presentations available for additional reviews*
- Presentation to the Board on June 10th
- Report writing/design continues through June
- Future STAC review points
- Release target is end of summer