

NEW YORK HARBOUR ESTUARY

A Comparative Study

Lorraine Chaffer, President GTANSW

New York New Jersey Harbour Source: Wikipedia Commons



Aerial view of Throgs Neck Bridge. Source: Wikipedia Commons

SYLLABUS LINK

Stage 5: Environmental change and management

Investigative study

Select ONE type of environment in Australia as the context for a comparative study with at least ONE other country.

Students:

- investigate the biophysical processes essential to the functioning of the selected environment
- investigate the causes, extent and consequences of the environmental change
- investigate the management of the environmental change

The following Case Study has been developed to support the use of the New York Harbour Estuary in the USA as a comparative study to Sydney Harbour Estuary.

A PowerPoint presentation provides detailed information, ideas and resources for teaching this case study. For members, this resource is available on the GTANSW website at <https://www.gtansw.org.au> in the dropdown menu – Resources – Presentations - 2018

Introduction

'New York Harbour is a large, iconic and complex body of water that has been extensively modified to support the development of a megacity. These modifications have affected the shorelines, waterflow, water quality, habitats and living resources of the harbour.'

Changes in topography and bathymetry have altered the landscapes and seascapes of the region, largely to support an active shipping port and intense human settlement. New York Harbor has been transformed from a region dominated by marshy shorelines and extensive submerged oyster beds to the present-day harbour with hardened shorelines, dredged shipping channels and remnant oysters that are unsafe to consume...'

New York Harbor: Resilience in the face of four centuries of development¹



Brooklyn & Manhattan Bridges, New York Harbour Source: Wikipedia Commons

NEW YORK HARBOUR ESTUARY: ACTIVITY GUIDE

Key inquiry questions

How are the environmental changes to New York Harbour and Sydney Harbour similar or different?*

Can the changes to Sydney and New York Harbour estuaries be managed using the same strategies to create healthy environments in the future?

ACTIVITIES

- Create an e-portfolio to record your responses to the following activities.
- Use the links and resources as well as your own research.

* Note: New York Harbour is also called New York New Jersey Estuary, New York Raritan Estuary and Hudson River Estuary. Harbour is spelt 'harbor' in the USA.

Location and spatial dimensions

1. Locate New York Harbour (USA) and Sydney Harbour (Australia) on a map or satellite image of each country.
 - For each place record the latitude, longitude and adjacent ocean. (This could be done using Google Earth, Google Maps or ArcGIS)
2. Using Google Earth.
 - Make screen captures of each estuary. Include a scale with each image. Label environmental features of New York Harbour and surrounds on the image throughout this investigation e.g. Manhattan, Staten Island, Statue of Liberty, Hudson River, New Jersey
 - Create digital terrain profiles (cross sections) at locations across each estuary. Save two contrasting images. See examples Images 1 and 2
 - Compare the size and shape of the two estuaries.
 - Compare the topography (landforms) and settlement around each estuary.
 - Record comparisons in a table of similarities and differences.
3. Study Map 1 of New York Harbour estuary.
 - Read Fact box 1.
 - Add to your table of similarities and differences to **Sydney Harbour Estuary**.

Indigenous past and early settlement

4. Research historical images of New York Harbour from the 1500's to the present. Illustrations¹ and 2 are examples.
 - Create a collage of images to show change over time including any that refer to the indigenous peoples.
 - Below your collage insert a text box - comment on any similarities or differences between the settlement and use of New York Harbour and Sydney Harbour over time.

Environmental features and processes

5. Examine Diagram 1, Fact box 2 and the Wildlife Poster²
 - Briefly outline the important natural processes that occur in estuaries.
 - Explain why New York Harbour supports a large diversity of wildlife

Environmental Change and management

6. Explore New York Harbour using AIRPANO at <http://www.airpano.com>
 - Select Grand tour of Manhattan
 - Select view 1 (financial District) and use the tools to explore NY Harbour
 - Identify Places e.g. Brooklyn, New Jersey, Staten Island, Manhattan, Statue of Liberty (Use the map to assist with this activity); natural areas and port facilities.
 - Investigate other views of NY/NJ Harbour (e.g. views 4, 5 or 10)
 - Estimate the % of armoured shoreline (seawalls)
 - Identify points of difference to Sydney Harbour

This activity could also be undertaken using Google Earth or other spatial technologies.

7. Work in Groups to examine the Look inside New York Harbour³ poster and State of the Estuary Fact Sheet (See resources attached).
 - Create two mind maps
 - a. One to illustrate the original features of the New York Estuary
 - b. One to illustrate environmental changes resulting from human activities

ENVIRONMENTAL CHANGE & MANAGEMENT

8. Investigate the impacts of ports and shipping OR industrial pollution on the harbour environments.
9. Assess the potential impact of climate change
 - In pairs watch one of the following video clips. Share key ideas with another pair.
Rising sea levels put New York City at risk <https://www.youtube.com/watch?v=-xLokKVdk7I>
How Climate Change Could Drown New York City https://www.youtube.com/watch?v=_zK6Grhp5Zk&t=90s
 - Compare Map 2 (vulnerability to sea level rise) to a similar Sydney Harbour map.
 - Investigate Hurricane Sandy and proposals to reduce the impact of future storms.
 - Write a statement about the climate change future of New York City and harbour
10. Revise the three main environmental issues facing Sydney Harbour Estuary.
Can the environmental changes to New York Harbour be categorised this way?
11. Case Study: The Oysters of New York Harbour: an example of habitat restoration.
Investigate the historical distribution, use, abuse and re-establishment of oyster habitats in New York Harbour Estuary. Start with *The Incredible Oyster Reef*⁴ and *Oyster-tecture*⁵ podcast resources. Research the *Billion Oyster Project*⁶.
12. Investigate one other initiative to improve the environmental quality and functioning of the New York Harbour Estuary. Examples include living shorelines, storm barriers, stormwater and waste management, education programs, community action.

Analysis

Work in groups to develop responses to the two inquiry questions. Share ideas with the class.

Communication

Work in pairs to develop a short 3-minute oral presentation titled *Our plan to restore and protect the New York Harbour Estuary*.

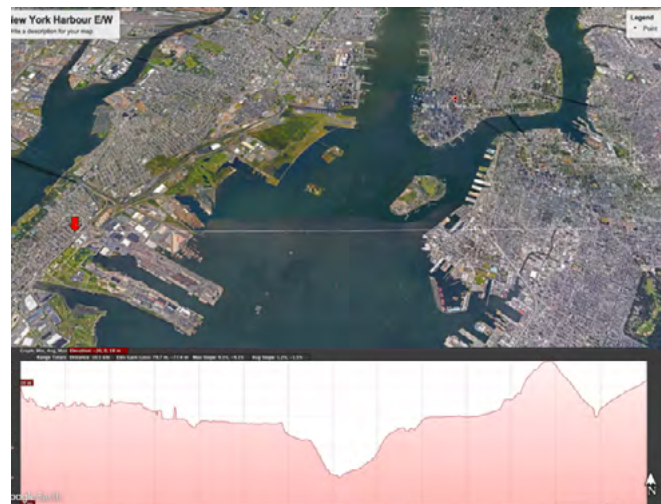
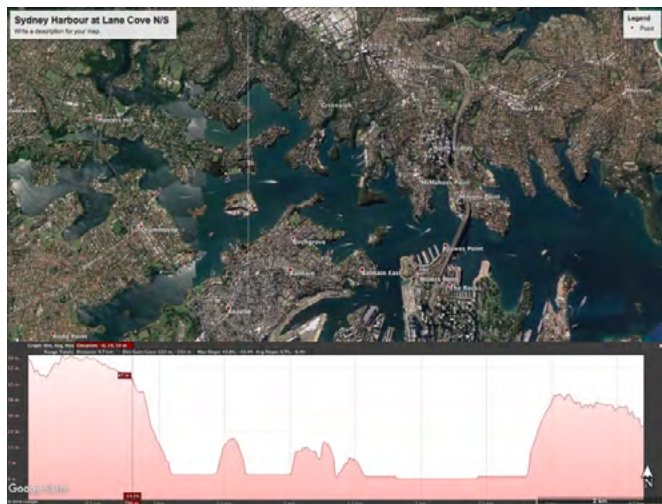
Endnotes

1. New York Harbor: Resilience in the face of four centuries of development. Judith M. O'Neil , Dylan Taillie, Brianne Walsh, William C. Dennison, Elisa K. Bone, David J. Reid , Robert Newton, David L. Strayer, Kate Boicourt, Lauren B. Birney, Sam Janis, Pete Malinowski, Murray Fisher.
Retrieved from Regional Studies in Marine Science 8 (2016) 274–286 on October 28th 2018 <https://www.sciencedirect.com/search?q=New+York+Harbor%3A+Resilience+in+the+face+of+four+centuries+of+development&authors=&pub=&volume=&issue=&page=&origin=home&zone=qSearch>
2. Wildlife of the New York New Jersey Harbor Estuary retrieved on October 28th 2018 from <http://www.harborestuary.org/educationalmaterials.htm>
3. A look inside New York Harbour retrieved on October 28th 2018 from <https://vizzliesvote.skild.com/entries/a-look-inside-new-york-harbor>
4. The incredible Oyster Reef (YouTube) – <https://www.youtube.com/watch?v=9V3yjCplc44>
5. 'Oyster-tecture' (Living Breakwaters) <https://99percentinvisible.org/episode/oyster-tecture/>
6. Billion Oyster project – <https://billionoysterproject.org>



COMPARATIVE STUDY RESOURCES

Images 1 and 2. Sample digital elevation profiles for Sydney Harbour and New York Harbour



Created by L Chaffer using Google Earth Pro

Map 1: New York New Jersey Estuary



Source: State of the Estuary Report 2012 Page 3 http://www.harborestuary.org/pdf/StateOfTheEstuary2012/SOE_Rprt.pdf

Source: http://www.fasttrackteaching.com/ffap/Unit_4_Cities/U4_Growing_Cities.html

Illustration 1: Port of New York.



Retrieved from <https://minimalgoods.co/free-downloads-of-large-old-new-york-city-maps/>

Illustration 2: The "bird's eye" view of New York City shown below is a drawing made around 1884. The Brooklyn Bridge is visible on the right, crossing over the East River. New Jersey is across the Hudson River to the left.

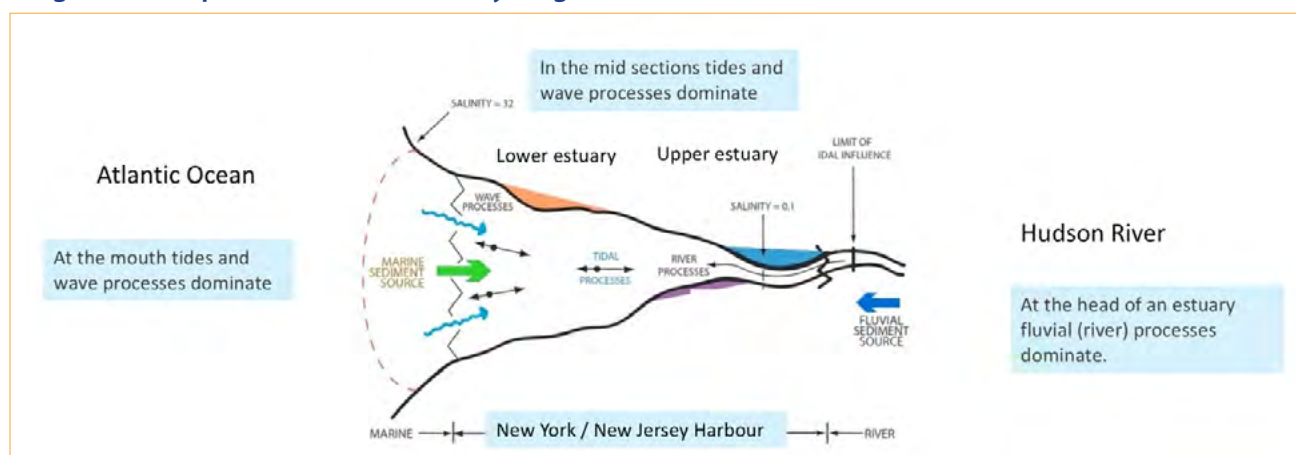


FACT BOX 1: A Drowned valley and tidal estuary

New York Harbour is one of the largest natural harbours in the world, and like Sydney Harbour, is very modified. The estuary is located at the mouth of the Hudson River where it empties into New York Bay, then the Atlantic Ocean. It is a drowned River valley but unlike Sydney, the original valley was broad and flat.

Fresh water from the Hudson, Hackensack, Passaic, Rahway and Raritan Rivers meets salt water from the Atlantic Ocean, flowing north on the 'in'tide, and south on the 'out' tide. Native Americans named the Hudson, "Muhheakantuck", meaning, "the river that flows two ways". The tidal influence reaches Troy, 250km upstream. At Staten Island, and in the lower estuary, the tidal range can be 1–2 metres. Intertidal zones contain a diversity of habitats that are rich in biodiversity including over 500 species of birds and fish.

Diagram 1: Simplified New York Estuary diagram.

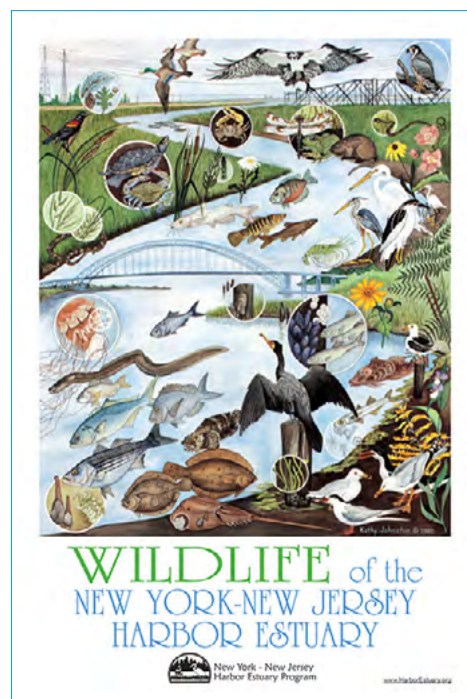


Adapted image. Source - Nature <https://www.nature.com/scitable/knowledge/library/estuaries-where-the-river-meets-the-sea-102734157>

FACT BOX 2: Habitats and biodiversity in New York Harbour

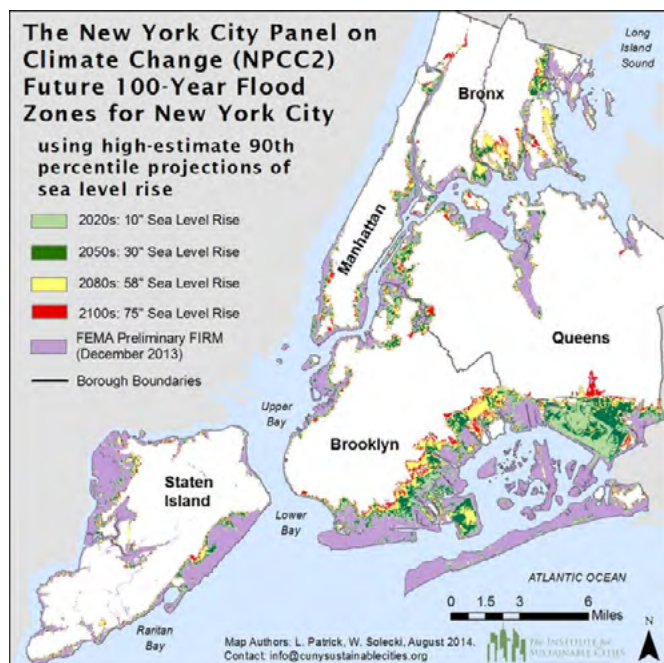
- **Shallow mudflats**
 - habitat for algae, crabs, clams & invertebrates,
 - food for fishes, e.g. striped bass and bluefish
- **Wetlands**
 - habitat for resident birds, mussels, fiddler crabs and fish
 - overwintering areas (migratory birds) and breeding grounds
- **68 islands**
 - nesting populations e.g. herons
- **Tributaries**
 - provide a gradient of unique habitats from saltwater to freshwater
 - over 100 fish species
 - for 16 species it is essential habitat

Source: New York Harbor: Resilience in the face of four centuries of development Regional Studies in Marine Science 8 (2016) 274–286



ENVIRONMENTAL CHANGE & MANAGEMENT

Map 2: Projected impacts of climate change



Source: <https://theconversation.com/building-climate-resilience-in-cities-lessons-from-new-york-52363>

Image 3 (below): The Port of New York and New Jersey is third largest port in the USA and the largest port on the Atlantic seaboard handling 3.7 million containers, 500,000 automobiles, and other goods coming in and out each year. Container ships, barges, oil tankers, cargo vessels, tugboats, and other merchant ships operate in the estuary.

Retrieved from State of the Estuary report http://www.harborestuary.org/pdf/StateOfTheEstuary2012/SOE_Rprt_HiRes.pdf

YouTube: A video about Chesapeake Bay oysters

A similar story occurred in New York. Start at 1 minute 10 seconds. Screen capture obtained 29/10/2018



Source: <https://www.youtube.com/watch?v=9V3yjCplc44>

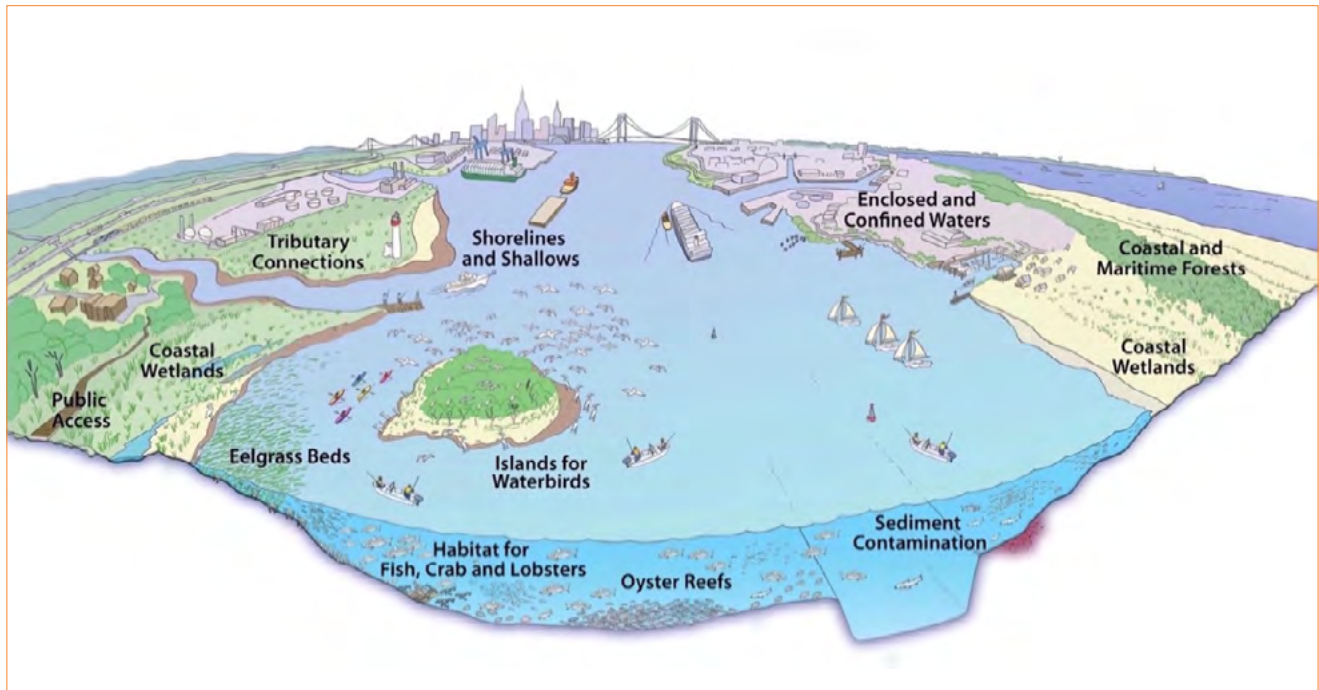
Podcast: 30-minute audio podcast Post Sandy to address climate change by suggestion options for the future



Source: <https://99percentinvisible.org/episode/oyster-tecture/> Screen capture obtained 29 / 10 / 2018



Diagram 2: Restoring the New York New Jersey Harbor Estuary



Retrieved from <http://www.harborestuary.org/watersweshare/resources.htm#crp>

The Comprehensive Restoration Plan (CRP) for the Hudson-Raritan Estuary (HRE) is a master plan to guide ecosystem restoration efforts throughout the estuary. It is intended to be used by all stakeholders (environmental and community groups, government agencies, and others), thereby allowing the whole region to work toward a series of shared restoration goals providing benefits to the estuary.

Image 4: Creating or recreating living shorelines



Retrieved 29/10/18 from <https://www.estuaries.org/first-national-report-on-living-shorelines-institutional-barriers-released>

A LOOK INSIDE NEW YORK HARBOR

NEW YORK HARBOR IS A LARGE, ICONIC, COMPLEX BODY OF WATER

The harbor is an important part of New York City and its millions of residents. Throughout history, New York Harbor has been massively changed and impacted by human activities. These changes have altered the shorelines, water flow, plants, and animals of the harbor. Historically, New York Harbor had marshy shorelines, oyster reefs, sand bars, and rocky reefs which were hazards to ships. The present day harbor created hardened shorelines (seawalls and riprap rocks), dredged channels for shipping, and a few, scattered remaining oysters that are unsafe to eat. However, improvements in water quality, largely by upgrading sewage treatment combined with the natural flushing by tides are helping to restore the harbor. These illustrations of New York Harbor help explain what is happening below the water surface—a look inside.

The New York Harbor region includes the five boroughs of New York City (Manhattan, Bronx, Queens, Brooklyn, Staten Island), Westchester County, New York, Nassau County on Long Island, New York and extensive regions of Northeast New Jersey. The complex waterways include the Hudson River and several New Jersey Rivers (Hackensack, Passaic, Rahway and Raritan Rivers) which all empty into New York Harbor. There are six bays that are contiguous with New York Harbor: Newark, Raritan, Sandy Hook, Lower New York, Upper New York and Jamaica Bays. There are two entrances into New York Harbor; Long Island Sound via the East River, and the Atlantic Ocean via the entrance between Rockaway Point and Sandy Hook.

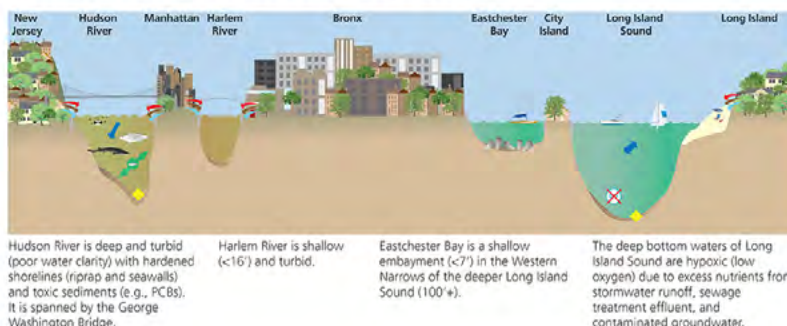


Four parallel east-west transects were established to provide insights into the natural and man-made features of New York Harbor. From north to south, these transects were the following: T1—George Washington Bridge transect, T2—Midtown Manhattan transect, T3—Statue of Liberty transect, and T4—Verrazano Bridge transect.

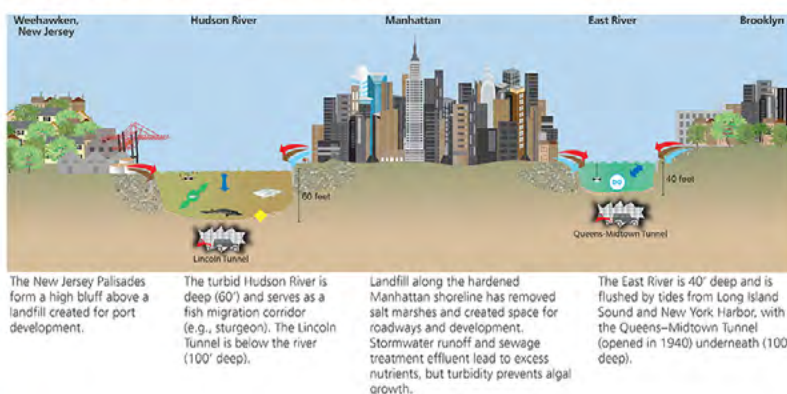
This poster is a product of the Curriculum and Community Enterprise for Restoration Science (CCERS), a National Science Foundation (NSF) funded project, with a diversity of partner institutions denoted by the logos.



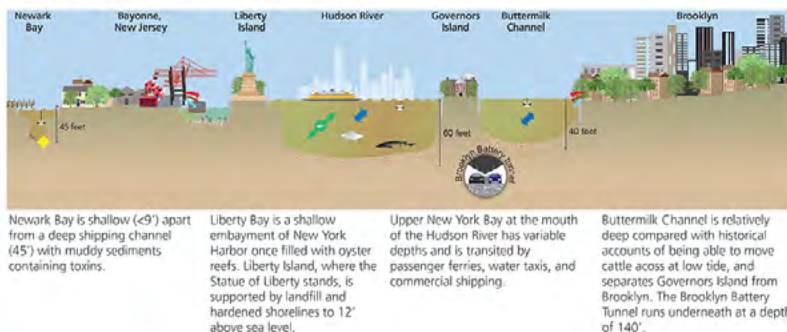
GEORGE WASHINGTON BRIDGE TRANSECT



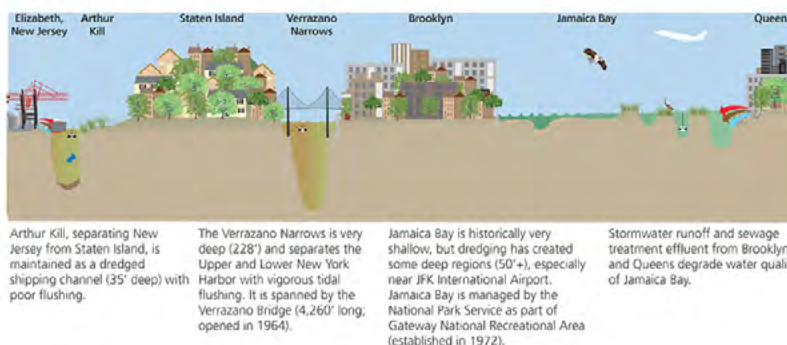
MIDTOWN MANHATTAN TRANSECT



STATUE OF LIBERTY TRANSECT



VERRAZANO BRIDGE TRANSECT



Habitat characteristics	Key Issues	Physical Processes
Water clarity	Nutrients	Tidal flushing
Landfill	Sediment	Riverine flow with tidal flushing
Sandy bottom	Stormwater runoff	
Muddy bottom		
Fish habitat		
Fish migration corridor		
	Hardened shoreline	
	Toxins	



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www.harborestuary.org

FACT SHEET

STATE OF THE ESTUARY 2012



The New York-New Jersey Harbor Estuary is home to a complex ecological system in the midst of a heavily developed metropolitan area.

Increasing environmental degradation brought about a public outcry, legislation, and numerous actions to bring the estuary back from the brink. Today, our estu-

ary's health is much better than it was 30 years ago, but many problems remain.

This fact sheet summarizes a few aspects of the "state of the estuary" including pollution, wildlife, and natural areas. A full report and related resources are available at www.harborestuary.org.

LIVING RESOURCES

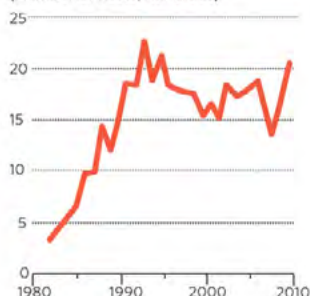
Estuaries are areas where rivers meet the sea, creating habitats for countless plants and animals. These rich ecosystems provide essential benefits, including nourishment, clean water, protection from floods and erosion, and recreational opportunities.

Urbanization and other human activities have profoundly changed our estuary. Many natural areas have been degraded or lost, but remaining habitats still provide invaluable resources and are in serious need of protection and restoration. While some species in the estuary are in poor condition, the success stories are encouraging.

Habitat: Although threats to remaining habitats persist in our region, loss and degradation have generally slowed in recent decades. There is growing recognition of the enormous value we derive from healthy ecosystems and the need to preserve and improve them. In 2009, a group that included many HEP partners drafted a Comprehensive Restoration Plan (CRP) for our estuary. This master plan is meant to guide conservation and restoration efforts in our region, leading to healthier habitats, cleaner air and water, aesthetic value, and recreational opportunities. This will translate into more livable and desirable communities, healthier families, and stronger local economies.

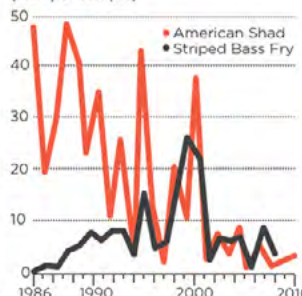
Harbor Herons (a group of wading birds) had disappeared from our estuary by the late 19th century. Improved environmental conditions and protection from hunting have contributed to their return. Their populations are now relatively stable.

HARBOR HERONS
(Number of nests, hundreds)



Fishes: In the Hudson River, striped bass declined because of overfishing, but populations have recovered after the implementation of fishing restrictions. American shad populations are at historic lows and it is hoped that recent fisheries closures will aid its recovery.

FISH ABUNDANCE
(Fish per sample)



CLIMATE CHANGE

Scientists agree that the earth's temperature is rising and that this is very likely the result of human activities, primarily the increasing use of fossil fuels such as coal and oil. The consequences of climate change could be catastrophic. Locally, we can expect more frequent and intense heat waves, rising sea levels, and intense rainstorms with more frequent flooding. These events may worsen many of the problems that currently affect our estuary, and create new ones. Among other negative effects, climate change may damage our homes, wastewater treatment plants, and other key infrastructure; and affect our health, transportation options, and the provision of electricity. Our estuary's ecosystem will suffer as wetlands are damaged and lost, shellfish growth slows, wildlife are driven away in search of cooler climates, and pests and invasive species spread more easily. We are already starting to experience some of these effects, and changes will be much worse if we fail to act. The task is daunting, but numerous efforts to mitigate and adapt to climate change are ongoing, and we as individuals can each make a contribution by working to conserve energy.

BIRD MIGRATION SHIFT IN N. AMERICA
(Average distance moved north, miles)

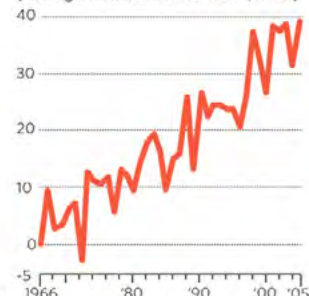
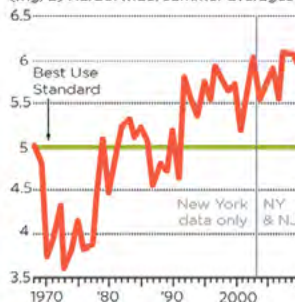


PHOTO: ANTHONY VANTICCI/ISTOCKPHOTO.COM
GRAPH: DPC/ALBION (HARBOR HERONS), PERSEC (SHAD, AMERICAN), & HADACH (STRIPED BASS) COMPANIES/ALBION SOCIETY (BIRD MIGRATION)

POLLUTION

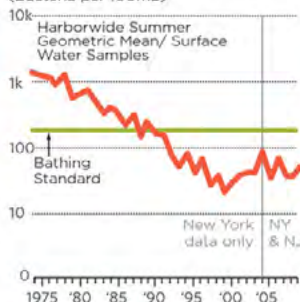
DISSOLVED O₂ IN BOTTOM WATERS (mg/L) Harborwide, summer averages



Nutrients and Dissolved Oxygen:

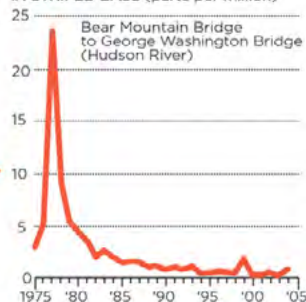
Excessive nutrients in our waters enable microorganisms to grow and consume dissolved oxygen, stressing or even killing valuable aquatic wildlife. Nutrient pollution in our estuary has decreased, thanks to investments in better wastewater treatment. While green infrastructure will help, nutrients are very difficult to remove, and further reductions will likely require complex and expensive improvements.

FECAL COLIFORM BACTERIA (Bacteria per 100mL)



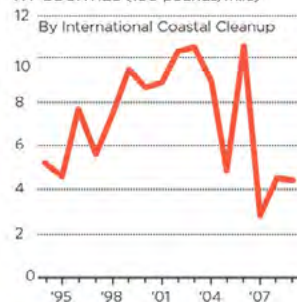
Pathogens: Pathogens are disease-causing microorganisms. Pathogen pollution is commonly the result of contamination by human or other animal feces. Pathogens enter waterways mainly from combined sewer overflows, which discharge a mixture of stormwater and sewage when rainstorms overwhelm wastewater treatment plants. Pathogen pollution affects our ability to swim and enjoy our waterways, and also contaminates shellfish, making them unsafe to eat. Improvements in our wastewater treatment infrastructure have generally resulted in cleaner waters. Progress in areas of our estuary that do not have good tidal flushing will likely be slower and more expensive. But ongoing and planned efforts are expected to bring us closer to the ultimate goal of a healthy estuary that can be enjoyed safely by all at any time.

POLYCHLORINATED BIPHENYLS (PCBs) IN STRIPED BASS (parts per million)



Toxic Chemicals: Toxic pollution is one of the most serious problems in our estuary, threatening wildlife, limiting the safe consumption of local fish and shellfish, and increasing the cost of port operations. Many toxic chemicals entered our estuary as a result of past industrial activities and have persisted in sediments, accumulating in the tissues of fish and other wildlife. The concentrations of several toxic chemicals have been decreasing slowly, but it is necessary to address past contamination to achieve further reductions faster. Recently, clean-up was initiated at two of the most notorious contaminated sites in our estuary: the Hudson River PCBs and Passaic River Diamond Alkali Superfund sites. These are significant steps, but much more work is necessary at these and other sites.

DEBRIS COLLECTED IN 8 NY COUNTIES (100 pounds/mile)



Floatable Debris: Litter and decaying structures such as piers and abandoned boats are the main sources of floatable debris on our beaches, shorelines, and waterways. Debris is not only an eyesore, it can harm people and wildlife, and cause damage to boats. Many groups are working to address this problem, and we can all do our part by generating less waste and disposing of trash properly. Floatable debris in our estuary may already be decreasing, but continued monitoring is needed to confirm whether this trend is real.



Little Blue Heron



Black-Crowned Night Heron



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NEIWPCC
New England Interstate Water
Pollution Control Commission

For more information on the State of the Estuary and for ideas on how you can help, visit www.harborestuary.org. We all need to do our part so that we can live, work, swim, travel, fish, canoe, bird-watch, learn, enjoy and preserve the wonderful treasure that is our estuary for generations to come.

NEW YORK HARBOUR ESTUARY STUDY

RECOMMENDED RESOURCES

Presentations

Lorraine Chaffer PowerPoint presentation: New York Harbour at GTANSW website <https://www.gtansw.org.au>
Dropdown menu – Resources – Presentations – 2018

- **Slides 1–5** Introduction
- **Slides 6–9** Place Geography
- **Slides 10–20** Environmental processes and Functioning
- **Slides 20–40** Environmental change and management

World Harbour Project: WEBINAR: New York Harbour (Register to view then go to Part 2) <https://register.gotowebinar.com/recording/8363243159295259907>

Academic paper

New York Harbor: Resilience in the face of four centuries of development

Judith M. O’Neil, Dylan Taillie, Brianne Walsh, William C. Dennison, Elisa K. Bone, David J. Reid, Robert Newton, David L. Strayer, Kate Boicourt, Lauren B. Birney, Sam Janis, Pete Malinowski, Murray Fisher

Retrieved from Regional Studies in Marine Science 8 (2016) 274–286 on October 28th 2018 <https://www.sciencedirect.com/search?qs=New+York+Harbor%3A+Resilience+in+the+face+of+four+centuries+of+development&authors=&pub=&volume=&issue=&page=&origin=home&zone=qSearch>

Reports

State of the Estuary report
http://www.harborestuary.org/pdf/StateOfTheEstuary2012/SOE_Rprt_HiRes.pdf

State of the Estuary 2012 Fact Sheet
http://www.harborestuary.org/pdf/StateOfTheEstuary2012/Factsheet_English.pdf

Restoring the New York New Jersey Harbor Estuary
Page 1 <http://www.harborestuary.org/watersweshare/resources.htm#crp>

Restore, Adapt, Mitigate from Restore Americas Estuaries https://www.estuaries.org/images/stories/RAE_Restore-Adapt-Mitigate_Climate-Chg-Report.pdf

Websites

New York New Jersey Harbour Estuary Program
<http://www.harborestuary.org/RaritanBayConf2015.htm>

Hudson River Estuary
<http://www.dec.ny.gov/lands/4923.html>

Port of New Jersey New York
<http://www.panynj.gov/port/>

Summary of restoration plans <http://www.nan.usace.army.mil/Media/News-Stories/Story-Article-View/Article/496506/us-army-corps-of-engineers-meet-with-stakeholders-and-discuss-progress-and-plan/>

Posters

Wildlife poster: *Wildlife of the New York New Jersey Harbor Estuary* <http://www.harborestuary.org/educationalmaterials.htm>

A Look Inside New York Harbour <https://vizzliesvote.skild.com/entries/a-look-inside-new-york-harbor>

Oysters

New York New Jersey Harbour Estuary Program / Habitat: Oyster Reefs <http://www.harborestuary.org/aboutestuary-habitats-oyster.htm>

‘Oyster-tecture’ (Living Breakwaters)
<https://99percentinvisible.org/episode/oyster-tecture/>

Billion Oyster project <https://billionoysterproject.org>

Why New York Schoolchildren Want to Grow a Billion Oysters <https://www.smithsonianmag.com/smart-news/why-new-york-schoolchildren-want-grow-billionoysters-180963085/#UpV4BTIzumkAsHaK.99>

The incredible Oyster Reef (YouTube) <https://www.youtube.com/watch?v=9V3yjCplc44>