Major Achievements in Oceanography

➢ Philosophy-Based

○ Antiquity

600 B.C. **Pythagoras**: Greek philosopher who thought the world was **round**

325 B.C. **Pytheas**: linked the **tides** to the movement of the **moon**

1543 Nicholaus **Copernicus** theorizes a **sun-centered universe**

1600s Galileo **Galolei** lays the foundation for **inductive reasoning**

○ Theories, Methods, & Research Institutes

1858 Alfred **Wallace** sends Darwin an outline of his theory of **Natural Selection**

1859 Charles **Darwin** proposes that **different species** arise through **isolation**

1876 **Wallace** proposes **biogeography** in *The Geographical Distribution of Animals*

1888 Spencer Fullerton **Baird** established **Wood's Hole**

1906 Prince Albert I of Monaco establishes the **Instut Oceanographique**

1946 Karl **Popper** introduces the philosophy of **Critical Rationalism** & founds the department of Philosophy, Logic, & Scientific Method at the London School of Economics

1949 William "Doc" **Ewing** forms the **Lamont-Doherty Earth Observatory**

○ Laws & Retrospections

1609 Hugo **Grotius** writes *Mare Liberum*, the foundation of all **modern sea law**

1890 Alfred Thayer **Mahan** publishes *The Influence of Sea Power upon History*

○ Environmentalism

1798 Thomas **Malthus** predicts that **population size** will always be **kept in check** by famine, disease, & widespread mortality. He also said that agricultural advancements couldn't enable limit-less population growth

1956 Eugene **Smith** chronicled the history of a small Japanese fishing town, **Minamata**, that got **mercury** poisoning from a local chemical factory

1962 Rachel **Carson** publishes ***Silent Spring*** initiating the environmental movement

1968 Paul Ralph **Ehrlich** publishes ***The Population Bomb***

1969 John **Holdren** & **Ehrlich** write that **overpopulation** is a problem & since then their work has focused on **causes** & **consequences** of **global climate change**

Present John **Holdren** is one of President Obama's Science Advisors

Major Achievements in Oceanography

➢ Exploration-based

○ Cartography

230 B.C. **Eratosthenes** calculates **Earth's circumference** & invents Longitude & Latitude

127 B.C. **Hipparchus**: arranges **Longitude** & **Latitude** on a **grid by degrees**

151 A.D. **Ptolemy**: creates the **first Atlas**

1569 Gerardus **Mercator** creates the **cylindrical map projection**

1760 John **Harrison** invents the **modern chronometer**

1769 Benjamin **Franklin** publishes the first chart showing the Gulf Stream

1957 Bruce **Heezen** & Marie **Tharp** create the **Heezen-Tharp Map** which is the first map of the **ocean floor** including the **Mid-Ocean Ridges**

○ Surface Discovery & Navigation

1450 **Prince Henry the Navigator** established a **school for the study** of geography, seamanship, shipbuilding, & navigation

1492 Christopher **Columbus** discovers the **Caribbean islands**

1522 Ferdinand **Megellan** **circumvents** the Earth

1570s Sir Francis **Drake** circum navigates the earth

1600s Henry **Hudson** explores **North America**

1768 Captain James C. **Cook** takes his first voyage aboard the ***Discovery***

1831 Charles **Darwin** departs on his 5 year voyage aboard the ***HMS Beagle***

1800s Captain Charles **Wilkes** begins the **South Seas Expedition**

1848 Alfred C. **Wallace** departs aboard ***Mischief*** & explored the **Amazon**

1854 **Wallace** travels through **Malaysia** & **Indonesia**

1870s Sir-Wyville **Thompson** goes on the ***Challenger expedition*** & publishes his accounts of the **dredging** done on this voyage of *the Depths of the Sea*

1877 Alexander **Agassiz** begins his **dredging** research aboard the ***Steamer Blake***

1893 Fridtjof **Nansen** does the 1st successful crossing of the **Arctic** aboard the *Fram*

1909 Admiral Robert **Peary** is the 1st person to reach the **geographic North Pole**

1911-12 Roald **Amundsen** is the 1st person to reach both the **North** & **South Poles**

○ Sub-Surface Discovery & Navigation

1818 John **Ross** takes the first samples of **deep seawater** & **sediments**, proposed the **emergence hypothesis**, & shows there's deep sea life at the poles

1930s Otis **Barton** & William **Beebe** become the 1st humans to reach **½ mile deep**

1960 Jacques **Piccard** & Don **Walsh** become the 1st men to reach the **Mariana Trench**, which is 10,915 meters (35,801 feet) deep

1977 John **Baross** discovers **Black Smokers**

1985 Robert **Ballard** finds the wreck of the ***Titanic***

Experiment-based

- **Biology**

1688 Francesco **Redi** **rejects** the theory of **spontaneous generation**

1700s Joseph **Priestly** discovered **photosynthesis**

1758 Carolus **Linnaeus** develops a system for **naming** & **classifying organisms**

1800s Antoine **Risso** "**Paleo-depth indicators**" & idea that depth indicates change

1800s **Lamarck** introduces the theory of **inheritance of acquired characteristics**

1801 **Lamarck** invents the term "**Invertebrate**"

1802 **Lamarck** invents the term "**Biology**"

1820s Charles **Cagniard-Latour : yeast** = non-motile organized globules capable of reproducing by budding

1836 William **Harvey** devises a taxonomy of **seaweeds**

1858 Alfred **Wallace** sends Darwin an outline of his theory of **Natural Selection**

1859 Charles **Darwin** proposes that different **species** arise through **isolation**

1876 **Wallace** proposes **biogeography** in *The Geographical Distribution of Animals*

1843 Edward **Forbes** proposed **Azoic Ocean Hypothesis** (no life below 300 fathoms)

1847 Hans Christian **Oersted** observed **plankton** for the first time

1800s Gregor J. **Mendel** discovers a mechanism of **inheritance** while working with peas

1857 T.H. **Huxley** supports Darwin's theory of Evolution & coins the term "**Agnostic**"

1887 Victor **Hensen** coins the term "**plankton**" & starts **biological oceanography**

1916 Federic **Clements** studies plant communities & finds that modified assemblages will react predictably through **biological control** (**Succession → Climax**)

1917 Joseph **Grinnell** coins the term "**niche**"

1920s Henry **Gleason** studies altered plant communities & finds that they don't always return to the same state, but instead are formed through **physical change**

1928 Albert Jan **Kluyver** & Cornelius van **Niel** work together to develop equations for **Respiration** & **Photosynthesis**

1946 Gordon **Riley** discovers the importance of **stratification** in initiating the **Spring Bloom** of Phytoplankton & Zooplankton

1950s Karl **Banse** studies **phytoplankton**

1950s Tom **Goreau** describes **Caribbean reef zonation**

1957 Evelyn **Hutchinson** describes niches as "**n**" **dimension hyperspace**

1960s Ramon **Margalef** says that the present animal community came from a previous set of communities & will evolve into a new set of communities

1961 J.H. **Connell** describes the **selective pressures** related to **predation** & **competition** for space in the **rocky intertidal**

1966 Bob **Paine** & John/Joan **Rutherford** worked together on **Population** & **Community theory** & say the **key to diversity lies in explaining the gaps**

1967 Alan **Longhurst** describes the **vertical distribution** of **zooplankton** in relation to the Eastern Pacific **oxygen minimum**

- **Biology** (continued….)
  - 1969 John **Ryder** describes the **Maximum Sustainable Yield** (MSY) of Fisheries
  - 1970 O.J. **Koblentz-Mishke** says that **plankton** are the **ocean's primary producers**
  - 1971 Thomas C. **Malone** describes **food webs**
  - 1971 Paul **Dayton** said that benthic communities are diverse because they're disturbed; **Lotka-Voltera + targeted disturbance = diversity**
  - 1973 Arnfried **Antonius** discovered 1st coral disease (Black Band Disease)
  - 1977 J.B.C. **Jackson:** corals are a **tropical western boundary phenomena** (up-wellings)
  - 1980 Colleen **Cavanaugh** suspects **chemosynthesis in tubeworms**
  - 1981 H. **Felback** finds **chemosynthesis in mussels**
  - 1981 Michael **Rex**: **deep sea diversity** is the highest at **intermediate depths**
  - 1987 Robert **Hessler** studied **hydrothermal vent ecology** & deep sea biodiversity
  - 1989 **Longhurst** describes the "**Biological Pump**"
  - 1990 David **Cushing** introduced the **Match/MisMatch hypothesis** which focused on timing, as a function of climate change, of phytoplankton blooms
  - 1991 **Longhurst** describes the role of marine biosphere in the **global carbon cycle**

- **Microbiology**

1500s	Girolamo **Francastoro** wrote about the **contagions** involved in diseases
1600s	Robert **Hooke** all living creatures are made up of **individual cells**
1683	Antony van **Leeuwenhoek** created a **solar microscope** → discovery of **bacteria**
1700s	Lazzaro **Spallanzani** discovers that most organisms are killed by **boiling water**
1796	Edward **Jenner** used **Cow Pox inoculations** to **immunize** against **small pox**
1812	Ferdinand **Cohn** suggests the **microbes** are involved in the **cycling of all mater**
1822	Enrico **Acerbi** theorizes that **parasites** exist, can enter our bodies, & the multiplication of these parasites inside our bodies causes **typhus fever**
1837	Friedrich **Kutzing** describes the **nucleus** of the cell & idea of **fermentation**
1853	John **Snow** makes the first connection between **infectious diseases** & drinking water contaminated with **sewage** (**Cholera** outbreak in London)
1862	Louis **Pasteur** develops the **pasteurization** process to prevent drinks spoilage
1867	Joseph **Lister** develops surgical **sterilization** techniques
1870	**Pasteur** works on immunizations for **anthrax**, **cholera**, & **rabies**; & develops sterilization techniques that lead to the development of autoclaves
1880	Sergei **Winogradsky** discovers the 1st known form of **chemoautotrophy**, **biological nitrification**: he studied sulfur-oxidizing bacteria & found that the bacteria ***Beggiatoa*** could utilize inorganic H_2S as an energy source & atmospheric CO_2 for carbon in the synthesis of cellular material
1887	R.J. **Petri** develops the petri dish for culturing bacteria
1890	Robert **Koch** publishes **Koch's postulates**
1898	Martinus **Beijerinck** describes **viruses**, & discovers **nitrogen-fixing bacteria**
1903	Lord **Rutherford** discovers **radioactive half life**
1909	Paul **Ehrlich** discovers "**magic bullet**" cure for **syphilis** (protozoan infection)
1911	Rutherford **Atom Model**: very small positively-charged nucleus orbited by e^-
mid-1900s	Paul P. **Yevich** : **Pathobiology** …"the wonderful world of unknowns"
1970	Lynn **Margullis** describes the origin of **Eukaryotic cells**
1974	Larry **Pomeroy** *Ocean's* ***Food Web****: A Changing Paradigm* in which he said that **microbes** played a key role in marine productivity
1975	John **Hobbie**'s paper "Direct Counts of Aquatic Bacteria by a Modified Epifluorescence Technique" becomes one of the most cited Ecology papers
1983	Tom **Fenchel** coins the term "**Microbial Loop**" in a paper supporting Pommeroy

- **Chemical**

1830s Justus von **Liebig** invents **Nitrogen-based fertilizers** & Law of the Minimum

1880 William **Dittmar** determines the **major salts in seawater**

1934 Alfred C. **Redfield**: **Redfield Ratio** which describes the ratio between **nutrients** in **plankton** & ocean water, **C:N:P = 106:16:1**

1950s Charles **Goldman** studies **eutrophication of lakes** (Lake Tahoe), nutrient limiting factors, impacts of climate change & weather, & time series data

1961 Charles D. **Keeling** : **Keeling Curve** measures the **atmospheric buildup of CO_2**

1967 Richard C. **Dugdale** studied **nutrient limitation** in the sea & uptake of new & regenerated forms of nitrogen in primary productivity

1979 Richard **Eppley** & Bruce **Peterson** discover **the F-ratio** which is the **fraction of total primary production fueled by nitrate** which they used to **estimate global oceanic primary production**

1985 Jorg **Imberger** modeled the **mixed-layer dynamics of lakes**, studies the underlying transport & mixing processes that control the health of the lake

1986 John **Martin**'s **Iron Hypothesis**: iron deficiency prevents phytoplankton blooms

1988 Akihiko **Hattori** studied **nitrate respiration** by marine bacteria

2002 Peter LeB **Williams** furthers our understanding of oceanic productivity, carbon cycling, metabolic balance, & importance of **oceanic microbial processes**

- **Geological**

1700s James **Hutton** develops the modern concept of **geologic time**

1800s J.D. **Dana** studied mountain-building, volcanic activity, & the **origin** & **structure of continents** & **oceans**

1857 T. H. **Huxley** theory of **Glaciers**

1891 Sir John **Murray** & Alphonse **Renard** **classify marine sediments**

1907 Bertram **Boltwood** calculates the **age of the Earth** through **radioactive decay**

1912 Alfred **Wegener** lectures on **Continental Drift**

1962 Harry **Hess** : **Sea Floor Spreading** driven by **convection** in Earth's Mantle

1965 John Tuzo **Wilson**: proposed the theory of **plate tectonics**

- **Physics**

1687 Isaac **Newton** explains how **gravity** works

1731 George **Hadley** uses **wind circulation patterns** to try to explain **trade winds**

1742 Andrers **Celsius** invents the **centigrade temperature scale**

1800s William **Ferrel** discovers **mid-latitude circulation cells** in both hemispheres

1835 Gaspard G. de **Coriolis** studies the **motion of bodies** on a **rotating surface**

1848 Lord **Kelvin** studies **thermodynamics** & develops the basis of **Absolute Zero**

1851 George G. **Stokes** creates **Stokes Law** which calculates the **terminal velocity** for a sphere falling in a **viscous medium**

1855 Matthew **Maury** assembles information from ships logs to create coherent **wind** & **current charts**

1861 James Clark **Maxwell** proposes a dynamic theory of **electromagnetic fields** & the **Maxwell Distribution** (statistical description of **kinetic theory of gases**)

1883 Osborne **Reynold** popularized **Stokes Law** by creating the **Reynold's number** (Re) which describes the balance between **inertial** & **viscous forces**

1894 Max **Plank** discovers **Black Body Radiation**

1898 Fridtjof **Nansen** explains quantitatively why wind caused water motion to not be in the direction of the wind by 20°-40° to the right in the N. hemisphere

1900s Ludwig **Boltzmann** develops the **Boltzmann equation** to describe the dynamics of an **ideal gas**

1900 Richard D. **Oldham** identifies the **P** & **S waves** on a **seismograph**

1902 V. Walfred **Ekman** quantitatively explains the **deflection** for idealized ocean

1918 Vilhelm **Bjerknes** formulates theory of **atmospheric fronts** & discovers the nature & formation of **extra-tropical cyclones** that cause mid-latitude weather

1923 Sir Gilbert **Walker** notices the shifts in atmospheric pressure differences between the Indian & Pacific Ocean, which would later become known as the **Southern Oscillation Index (SOI)**

1942 Melvin **Calvin** discovered the **Calvin Cycle**

1947 Howard **Sverdrupt** finds the connection between the **wind** & **Equatorial** & **Eastern Boundary Currents**

1948 Henry **Stommel** shows that it is the variation of the **Coriolis Parameter** with **latitude** that causes the **intensification** of the **Western Boundary Currents** in the major ocean gyres

1950 Walter **Monk** combines the concepts of Ekman, Sverdrup, & Stommel to explain the main features of the entire **wind-driven circulation pattern**

1953 **Sverdrupt** proposes the **Critical Depth** model to explain the rapid growth & accumulation of phytoplankton biomass in the spring, the critical depth is the depth at which photosynthesis = respiration

1975 Reuben **Lasker**'s **Stable Ocean Hypothesis**: stability is necessary for phyto-plankton blooms, larvae take advantage of this by staying with prey patch

1991 Wallace **Broecker** finds that the **Global Ocean Conveyor** periodically shuts down, & deep water formation stops & causes an ice age to begin

- **Mathematics, Statistics, & Modeling**

1735 Leonhard **Euler** introduces the use of **exponential functions** & **logarithms** in analytical proofs, & developed infinitesimal calculus & graph theory

1865 Johann **Forchhammer** develops the "**Principal of Constant Proportions**": the ratio of major **salts** in seawater from various locations is constant

1880s Sergei **Winogradsky** proposed the ecological classification system of **Autochthonous (K)** versus **Zymogenous (R)** organisms

1900s R.A. **Fisher** created the foundation of modern **non-parametric statistics**, Analysis of Variance (ANOVA), Maximum Likelihood, z-distribution

1900 Carl David **Runge** & M.W. **Kutta** developed the **Runge-Kutta method** for **solving** ordinary **differential** equations numerically

1900s Alfred **Lotka** created the **Lotka-Volterra** (**predator-prey**) model which uses **differential** equations to describe population dynamics

1913 Leonor **Michaelis** & Maud **Menton** develop the **Michaelis-Menton equation** relating the initial reaction rate (v_0) to the **substrate concentration** (S) in which the maximum rate is the v_{max} asymptote

1930s Jacques **Monod** developes the **Monod equation** which is the first & simplest description of how **substrate concentration affects growth**

1949 Edward **Simpson** develops the **Simpson's Diversity Index (D)** which says that in highly diverse communities there's a decreased risk of encountering the same species twice (works best when talking about the most abundant species & not the whole community), he also studied Probability Theory

1953 **Odum's** publish the *Fundamentals of Ecology*, in which **Howard** wrote about energetics & introduced his **energy circuit language** (**energese**) & **Eugene** wrote about **systems ecology**

1976 Robert **May** proposes that you don't have to solve the equation fully, you just need to know certain parameters in order to show that the equilibrium will still work out to 1 species surviving

1994 Robert **Aller** creates a mathematical model for **Bioturbation**

Major Achievements in Oceanography

- **Technology-based**
  - **Inventions**

    1608 Hans **Lippershey** invents the **telescope**

    1861 James Clark **Maxwell** creates the first **color photograph**

    1895 Rudolf **Diesel** invents the **diesel engine**

    1895 Guglielmo **Marconi** invents the **wireless telegraph**

    1909 Ole **Evinrude** invents the **outboard engine**

    1943 Jacques **Cousteau** & Emile **Gagnan** invent the **SCUBA regulator** & **tank** combination, the "**Aqualung**"

  - **Computers**

  - **Satellites**

  - **Digital Imagery**

  -