Bio 362 (Marine Biology)
Spring 2017
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Final Exam Study Guide

Note: the final is cumulative. Much of the material on this guide was also covered on Exams 1 & 2.

1. Definitions (be able to define & give an example if appropriate)

Properties of water:
Hydrogen bonds, cohesion, viscosity, pH, rule of constant proportionality, dynamic similarity

Oceanography
Topographical features of seafloor (shelf, abyssal plain, etc.), depth zones (epipelagic, neritic, etc.). Hadley cell, Ekman transport, pycnocline, thermocline, HNLC

Nearshore oceanography
Waves, swell, Eulerian vs. Lagrangian measurements of flow, significant wave height, advection vs. diffusion, boundary layers (3 types at 3 scales)

Intertidal communities
Spring vs. neap tide, important tide levels (MLW, MLLW, etc), zonation, settlement vs. recruitment, keystone vs. diffuse predator, suspension vs. deposit feeding, thixotropy, meiofauna, redox zone, bioturbation, epibenthic, epifauna, infauna, demersal, microbial stripping hypothesis, particle size selection by suspension feeders

Estuaries
Estuary, flocculation, stenohaline vs. euryhaline, anadromy vs catadromy, osmoregulation vs. osmoconformer, hypoxia, allochthonous vs. autochthonous, retention time, turnover time

Salt marshes & Mangroves
Halophilic, halophyte, accretion, subsidence, aerenchyma, pneumatophore, lenticel, prop root

Organisms of the epipelagic:
Plankton, nekton, holoplankton/meroplankton, homeothermy/poikilothermy, countercurrent exchange, hyperosmotic/hypoosmotic, autotrophic/heterotrophic/mixotrophic, ram feeding/suction feeding, osmoconformer/osmoregulator, planktotrophic, lecithotrophic, direct development, lateral line, ampullae of Lorenzini, otolith, echolocation

Productivity/food webs:
compensation point, saturation point, compensation depth, critical depth, accessory pigment, Redfield ratio, photoheterotrophy, DOC, TEP

Coral Reefs
hermatypic, zooxanthellate, constructional, atoll, barrier reef, fringing reef, adaptive bleaching, sequential vs. simultaneous hermaphroditism, protogyny

Kelp & Seagrass
Haplodiploid life cycle (Sporophyte/Gametophyte), epiphyte, grazing halo

Deep water
Black smoker, white smoker, trophosome

Polar
Antarctic convergence, melt pond, types of ice (frazil, nilas, etc.)

Fisheries
Fishery, fishery stock, MSY, CPUE, BOFF, age structure, LEP, Critical Replacement Threshold, Stock-Recruit curve, ratchet effect, bycatch, ITQ, TURF, MPA, "fishing the line"

Climate/human effects
Greenhouse effect, ENSO, NAO, PDO, IPCC, RCP

2. Details to know
• General ocean circulation patterns (major ocean gyres and currents)
• Types of waves, parts of a wave, celerity, relationships to bottom depth
• Types of tides (diurnal, semidiurnal, mixed), what type of tides are found along the coast of North America
• Locations of rocky intertidal North America. Differences in rocky intertidal communities between Pacific & Atlantic coasts
• Typical rocky intertidal zonation patterns: laminarian macroalgae – mussels – barnacles – snails
• Names of larval forms of major intertidal invertebrate fauna (bivalves, crustaceans, seastars)
• Major taxa of intertidal invertebrates & key distinguishing traits: bivalves, gastropods, amphipods, isopods, decapods, cirripedes, asteroids, polychaetes
• Why is H_2S common in the redox zone, and why are the sediments black?
• Types of predation & strategies used by predators in soft sediment habitats; strategies used to avoid predation
• Geomorphological classifications of estuaries, major distinguishing features of each
• Circulation-based classification of estuaries, major distinguishing features of each
• Factors producing mixing in estuaries
• How freshwater vs. saltwater bony fish osmoregulate. Hormones affecting chloride cell function. Contrast to how elasmobranchs osmoregulate

• Major species in southeastern US salt marshes, and their ecological roles: *Spartina alterniflora, Spartina patens, Juncus, Distichlis, Salicornia, Iva*
• Factors limiting mangrove distribution
• Functional roles of mangrove forests
• 3 major North American mangrove tree species (common & genus name only), distinguishing features, adaptations to marsh environment
• Head-down vs. head-up deposit feeders

• Major groups of phytoplankton: know names, whether they are motile or not, accessory pigments, and storage products
• Toxic effects of dinoflagellates
• Major groups of zooplankton, key distinguishing features, modes of feeding: Choanoflagellates, Heterokonts, Ciliates, Hydrozoans, Siphonophores, Cubozoa, Scyphozoa, Ctenophora, Salps, Appendicularia, Copepods, Euphausia, Pteropoda, thecosomates vs. gymnosomates, Chaetognatha
• Copepod anatomy
• Copepod life cycle (Nauplius, Copepodite, Adult, diapause/resting eggs. Number of stages is not necessary)
• Major groups of nekton; know an example of a typical organism in each group and a distinguishing trait. Osteichthyes, Chondricthyes, Mammalia, Odontocetes, Mysticetes, Phocidae, Otariidae, Cheloniidae, Sphenisciformes, Procellariformes, Pelecaniformes, Suliformes, Charadriiformes, Cephalopoda.
• Broad taxonomy of corals: Anthozoa, Hydrozoa, Octocorallia, Hexacorallia, Scleractinia, which ones are hermatypic, zooxanthellate, constructional
• Important grazers & coral predators on coral reefs
• Physical requirements for reefs (water temp, clarity, etc)

• Physical requirements for kelp & seagrass presence
• Major kelp species (*Laminaria* & *Macrocystis*) & their general geographic distribution.
• Major seagrass species (*Zostera* & *Thallasia*) & general geographic distribution
• Anatomy of a kelp & seagrass plant
• Sulfur biochemistry: in what type of reactions is sulfur a product ($S0_4$ used a e- acceptor, producing H_2S) vs. reactant (H_2S is oxidized to S). Where do those two different processes occur and why?
• Successional stages in whale falls
• What makes *Osedax* worms unique?
• Successional stages in cold seeps
• Dominant hydrothermal vent organsims, their means of feeding. Alvinellid worms, Vestimentiferan worms (*Riftia*), *Rimicaris*, Yeti crabs. Why do many of these organisms have pink or red gills? Why are many of their bodies white?
• Main features of Arctic & Antarctic oceans: shelf width, river input, pack ice seasonality, temperature-salinity patterns & stratification with depth, major circulation patterns, factors affecting 1º productivity, differences in benthic communities
• Major effects of ocean acidification on calcifying species
• Factors contributing to global sea level rise

3. Concepts (understand these ideas well enough to apply the concept to a novel situation)
• What are the consequences of hydrogen bonds? Latent heat of vaporization/fusion, heat capacity, freezing point depression/boiling point elevation
• Density of seawater, factors affecting it
• Laminar vs. turbulent flow. Effects on transport, particle encounter rate, swimming, feeding
• Plate tectonics: difference between spreading regions (oceanic ridges), subduction zones, trenches, transform faults
• General pattern of atmospheric circulation (circulation cells. Where are low and high pressure zones? Prevailiing winds at latitude)
• Coriolis effect. Where does it produce upwelling? Downwelling?
• Deepwater formation, thermohaline circulation. Why does deepwater form where it does?
• Orbital motion of waves, relationship to water depth, Stokes drift
• Velocity gradients/boundary layers. How do they develop, what affects their thickness (relationship to Re). Consequences of boundary layers for benthic organisms
• How do organisms respond/adapt/take advantage of the predicatiblity and timing of the tides?
• Tides, factors affecting magnitude, timing
• Critical tide levels
• Sources of physical stress in the intertidal (rocky & soft)
• Causes of zonation in each intertidal community (abiotic vs. biotic)
• Hypothesized effects of coastal upwelling on recruitment and settlement in the intertidal
• Pre- and post-settlement factors affecting recruitment. How to design experiments to test for those factors.
• Adaptations & strategies used by bivalves & gastropods for respiration, avoiding dessication, movement
• Compare & contrast the intertidal habitats based on various physical stresses, factors (e.g., wave energy, sediment grain size, etc)
• Compare & contrast soft sediment habitats in terms of physical factors (grain size, wave energy) and food web (e.g., source of primary productivity)
• Biological effects of redox zone, effects of organisms on redox zone.
• Strategies used by organisms to cope with drag & flow
• Biological consequences of estuarine sediment flocculation
• Why are estuaries relatively species poor?
• Patterns of estuarine fish habitat use (residents vs. migrants). What are the relative advantages of each strategy?
• Strategies that estuarine larvae use to exit & return to the estuary
• Role of facilitation in salt marshes
• Trait mediated effects of predators
• Role of grazing in salt marshes. Role of *Littoraria*

• Stokes law: ways to reduce sinking rate at low Re
• Photosynthesis: pattern with depth, critical depth theory & critiques of it
• Relative loss of different light wavelengths with depth (exact depths not necessary, just general pattern)

• Phosphorus cycle. Where does P come from, what causes it to be locally abundant?
• Nitrogen cycle. Major pathways and forms of N. How does it enter marine ecosystems, what causes it to be locally abundant?
• Forms of N used by phytoplankton, relative abundance vs. depth in mixed layer
• HNLC zones, iron limitation.
• Vertical mixing, critical depth theory. Two-layer model of ocean mixing. Seasonal and regional variation in critical depth, phytoplankton bloom, and zooplankton bloom.
• Major hypotheses for the timing of the spring bloom: Sverdrup's critical depth theory, dilution/recoupling, stratification onset
• Diurnal vertical migration. Explanations & evidence for each
• Primary production: what factors limit it with depth, and in different regions/latitudes of the ocean
• Nekton adaptations. Buoyancy, lift, pressure drag, swimming, visibility, feeding, salt balance, vision, olfaction, reproduction
• Microbial loop, key elements in the planktonic food chain

• Main spaceholding groups on coral reefs, modes of feeding & contribution to habitat (coral, sponge, algae)
• Typical zonation of reef (reef crest, reef flat, etc.) & types of species in each zone
* How can coral reefs be so productive despite oligotrophic water?
• Examples of antipredator adaptations on reefs
• Tradeoffs between brooding & broadcast spawning reproductive strategies
• Examples of facilitation on reefs (who is involved, how do they benefit?)
• Cleaner/client relationships on reefs. How does each party cheat & be honest, how is mutualism enforced.
• Factors affecting coral bleaching & explanations for adaptive bleaching
• Alternate states on reefs
• Alternate stable states vs. phase shifts; hysteresis

• Basic form of kelp & seagrass food webs. Importance of grazers/herbivores, detritus, epifauna relative to each other and other habitats (e.g., salt marsh)
• Alternate states on kelp forests/barrens. Factors leading to each state
• Explanation for latitudinal variation in herbivory by fishes
• Differences between kelp & seagrass
• How do coral reef fishes use nearby seagrass habitat? (foraging, juvenile nurseries)
• Factors structuring communities in soft sediment habitat
• Explanations for high diversity in deep sea benthic communities
• Differences in physical structure, energy sources & community structure between cold seeps & hydrothermal vents
• Factors producing zonation in vent communities
• Different strategies for larval dispersal in vent species
• How/why do brinecicles form? What effects do they have on the benthos?
• Role of krill, salps, pack ice, and ice algae in Antarctic food web
• Ocean acidication: why does it occur (chemically), what are some effects on organisms?
• Relationship between fishery effort and fishing yield, MSY
• Growth overfishing vs recruitment overfishing

• Factors complicating traditional stock assessments & MSY calculations: ill-defined stock structure, age structure, uncertainty in stock-recruit curve, ratchet effect, uneven spatial distributions of fish & fishers
• Shifting baselines
• Fishing down vs. through the food web
• BACIPS design
• Effects of El Niño/Southern Oscillation and Pacific Decadal Oscillation on marine communities
• carbon-bicarbonate equilibrium in the ocean, and its relationship to ocean acidification

Things you should know that were not in lecture but are in the book:
Ch 2: Material on El Niño, North Atlantic Oscillation, Pacific Decadal Oscillation (pp. 24-26)
Ch 4: The meaning of temperature limits (pp. 75-78)
Ch 10: Measuring primary productivity (pp 229-231)
Ch 13: Suspension & deposit feeding (pp 288-297)
Ch 14: Invasions in intertidal communities (pp 330-332)

Sections in the book not to worry about:
In general, you will not be tested on material in the "going deeper" and "hot topics" boxes.

Ch 9: "Phytoplankton succession..." (pp 216-219)
Ch 10: "Satellite color scanning and productivity models" (pp 231-233)
Ch 11: You need to know the names of the major phyla (e.g., know that porifera = sponges) and the material in the "Other features" blurb under the "Basic facts" for each group, but do not worry about additional details in the text.
Ch: 15 "Coral species: distinguishing genetic differences from plasticity of form"
Ch. 16: "Sampling subtidal benthos"
Ch. 17: "Speciation, extinction, and biogeographic factors"
Ch. 17: "Major gradients of species diversity"
Ch. 17: "Marine invasions"
Ch. 18: "Overexploitation of whales: a case history"
Ch. 18: "Other types of degradation"
Ch. 19: you are only responsible for "Nutrient input and eutrophication"