**Marine Science 2 Framework– Marine Biology; Castro, Huber (2016-2017)**

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| **Time Frame** | **Chapter/Lesson** | **Suggested Science Activities – depending on availability of equipment, supplies and time.**  | **Vocabulary** | **NGSSS** |
| **1st 9 Weeks** |  |  |  |  |
| Weeks 1-4 | Introduction to course and programCh. 1 – The Science of Marine Biology Discuss the process of doing science The Ecology of Florida* geological history
* climate
* biogeographic regions of the state
 | Teachers will have the option of either conducting labs from the lab program or having the students conduct their own research projects. LAB PROGRAM – LAB 1: WHO IS TALLER? Research projects can begin and end within one quarter (repeating new ones each quarter), begin and end in a semester, or continue over the course of the entire school year. Research projects can be instructor designed or student designed (with instructor’s approval). Students can work independently or in teamsSee Appendix A for outline and rubric for research projects. Quarter Projects Week 1 – project selection Week 2 – literature search Week 3 – develop hypothesis; design experiment Week 4 – set up experiment; begin samplingSemester Projects Same as aboveYear-long projects Same as above  | Inductive reasoningDeductive reasoningHypothesisIndependent variableDependent variableControlMeanMedianModeTheoryCoastal plainAlluvial riversTannic riversSand hillsSink holesArtesian springsMarshSwampSubtropicalBiogeographic barriersSpecies dispersalNativeNon-nativeInvasiveDrowned river valley | SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presentSC.912.N. 1.4 Identify sources of information and assess their reliability according to the strict standards of scientific investigation. SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations and provide examples from the content begin studied. SC.912.N.2.4 Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. SC.912.N.2.5 Describe instances in which scientists’ varied backgrounds, talents, interests, and goals influence the inferences and thus the explanations that they make about observations of natural phenomena and describe that competing interpretations (explanations)SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in scienceSC.912.E.6.4 Analyze how specific geological processes and features are expressed in Florida and elsewhereSC.912.E.7.8 Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectivelyMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.910.4.2.2 The student will record information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Weeks 5-6 | Ch. 10 – An Introduction to Marine Ecology* population dynamics
* community dynamics
* movement and transfer of energy within an ecosystem
* biogeochemical nutrient cycles
 | LAB PROGRAM – LAB 2: SAMPLING PLANKTON IN THE MARINE ENVIRONMENTQuarter Projects Week 5 – continue sampling Week 6 – complete sampling; begin data analysisSemester Projects Week 5 – continue sampling Week 6 – continue samplingYear-long Projects Same as above  | Abiotic Population CommunityCarrying capacityLimiting resourceIntraspecific competitionInterspecific competitionCompetitive exclusionResource partitioningNicheTrophic levelSymbiosisEcologyBenthosPlanktonNektonAutotrophHeterotrophPrimary productivityBiomassBiodiversityStanding stockNutrients | SC.912.E.7.4 Summarize the conditions that contribute to the climate of a geographic area, including the relationship to lakes and oceansSC.912.E.7.9 Cite evidence that the ocean has had a significant influence on climate change by absorbing, storing, and moving heat, carbon, and waterSC.912.P.10.2 Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantitySC.912.L.7.5 Analyze how population size is determined by births, deaths, immigration, emigration, and limiting factors (biotic and abiotic) that determine carrying capacity SC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.901.2.2.3 The student will organize information to show understanding or relationships among facts, ideas, and events (e.g., representing keys points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Weeks 7-8 | Ch. 11 – Between the Tides* Shifting sands
* Living sediment
 | LAB PROGRAMLAB 2 – CONTINUEDQuarter Projects  Week 7 – complete analysis; begin paper and/or power point Week 8 – papers are due; power point presentationsSemester Projects  Week 7 – continue sampling Week 8 – continue samplingYear-long Projects same as above | InfaunaSubtidalInterstitial waterAnoxicAnaerobic respirationMeiofauna | SC.912.E.6.6 Analyze past, present, and potential future consequences to the environment resulting from various energy production technologiesSC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.901.2.2.3 The student will organize information to show understanding or relationships among facts, ideas, and events (e.g., representing keys points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Week 9 | **QUARTER EXAM** | Quarter Projects – clean labSemester Projects – summary update dueYear-long Projects – summary update due |  |  |
| **2ND 9 WEEKS** |  |  |  |  |
| Weeks 1-8 | Ch. 12 – Estuaries* Salinity within estuaries
* Substrates found on bay bottoms
* Motion of water within estuaries
* Surviving in a physically dynamic system
* Life in the open water of estuaries
* Life on the mudflats
* Life in the salt marsh
* Life in mangrove swamps
 | LAB PROGRAMWeeks 1-4LAB 3 – MEASURING SEAGRASS PRODUCTIVITYWeeks 5-8LAB 4 – ANALYZING A FIDDLER CRAB COLONYQuarter Projects Week 1 – project selection Week 2 – literature search Week 3 – develop hypothesis; design experiment Week 4 – set up experiment; begin sampling Week 5 – continue sampling Week 6 – continue sampling Week 7 – complete analysis; begin paper and/or power point Week 8 – papers are due; power point presentationsSemester sampling Weeks 1-6 – continue sampling Week 7 begin and complete data analysis Week 8 papers are due; power point presentations Week 9 clean labYear-long Projects – continue sampling  | EstuaryBarrier islandSalt wedgeDiurnal tideTide lineSubstrateEuryhalineStenohalineBrackish waterOsmoconformersOsmoregulatorsSucculentsSubmergent plantsEmergent plantsAnadromousCatadromousDetritusEpifaunaDeposit feedersFilter feedersWetlandNitrogen fixationSeagrassEutrophication | SC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and successionSC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.901.2.2.3 The student will organize information to show understanding or relationships among facts, ideas, and events (e.g., representing keys points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Week 9 | **SEMESTER EXAM**  | Quarter Projects – clean labSemester Projects – clean labYear-long Projects – continue sampling  |  |  |
| **3RD 9 WEEKS** |  |  |  |  |
| Weeks 1-4 | Ch. 13 – Life on the Continental Shelf* physical environment
* soft bottom communities
* hard bottom communities
* seagrass meadows
* artificial reefs
 | LAB PROGRAMLAB 5 – REPRODUCTIVE BEHAVIOR OF LOCAL MARINE ANIMALS Quarter Projects Week 1 – project selection Week 2 – literature search Week 3 – develop hypothesis; design experiment Week 4 – set up experiment; begin samplingSemester Projects - same as aboveYear-long Projects - continue sampling  | SubtidalSublittoralNertic zoneBenthosNektonPlanktonStratificationSubstrateInfaunaEpifaunaSessileLithogenous sedimentBiogenous sedimentRecruitmentPrimary producerDetritusMeiofaunaDeposit feedersFilter feedersDemersalPelagicSeagrassEpiphyteNitrogen fixation | SC.912.E.6.4 Analyze how specific geological processes and features are expressed in Florida and elsewhereSC.912.E.6.6 Analyze past, present, and potential future consequences to the environment resulting from various energy production technologiesSC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and successionSC.912.L.7.5 Analyze how population size is determined by births, deaths, immigration, emigration, and limiting factors (biotic and abiotic) that determine carrying capacity SC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.910.4.2.2 The student will record information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Weeks 5-8 | Ch. 14 – Coral Reefs* the biology of corals
* conditions required for reef development
* different types of coral reefs
* populations and communities found within the reef and their ecology
 | LAB PROGRAMLAB 6a – ESTIMATING POPULATIONS IN THE MARINE ENVIRONMENTLAB 6b – ARE MANATEE POPULATIONS RECOVERING Quarter Projects Week 5 – continue sampling Week 6 – complete sampling; begin data analysis Week 7 – complete analysis; begin paper and/or power point Week 8 – papers are due; power point presentationsSemester Projects – continue sampling Year-long Projects – continue sampling | Calcium carbonateCndiarianPolypZooxanthallaePlanulaCoralline algaeBryozoanCoral bleachingEutrophicationFringing reefBarrier reefAtollReef flatReef slopePatch reefCoral knollsCay (Key)ButtressWindwardLeewardSymbiosis | SC.912.E.6.4 Analyze how specific geological processes and features are expressed in Florida and elsewhereSC.912.E.7.8 Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectivelySC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and successionSC.912.L.7.5 Analyze how population size is determined by births, deaths, immigration, emigration, and limiting factors (biotic and abiotic) that determine carrying capacity SC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and successionSC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.910.4.2.2 The student will record information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Week 9 | **QUARTER EXAM** |  Quarter Projects – clean labSemester Projects – summary update dueYear-long Projects – summary update due |  |  |
| **4TH 9 WEEKS** |  |  |  |  |
| Weeks 1-3 | Ch. 15 – Life Near the Surface* organisms of the epipelagic zone
* surviving in the open ocean
* food webs, nutrients, and productivity in the open ocean
 | LAB PROGRAMLAB 7 – USING ECOLOGICAL METRICS TO ASSESS THE STATUS OF A COMMUNITYQuarter Projects Week 1 – project selection Week 2 – literature search Week 3 – develop hypothesis; design experiment Week 8 – papers are due; power point presentationsSemester Projects – continue sampling Year-long Projects – continue sampling  | Pelagic EpipelagicPhotic zonePhytoplanktonZooplanktonAlgal bloomSalpsSiphonophoresMeroplanktonHoloplanktonNeustonPleustonVertical migrationMarine snowThermoclineUpwellingEkman transportEl NinoLa Nina | SC.912.E.7.2 Analyze the causes of the various kinds of surface and deep water motion within the oceans and their impacts on the transfer of energy between the poles and the equatorSC.912.P.10.2 Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantitySC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.910.4.2.2 The student will record information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Weeks 4-6 | Ch. 16 – The Ocean Depths* the mesopelagic zone
* the bathypelagic zone
* the abyss
 | LAB PROGRAMLAB 8 – INVENTORY AND MONITORING A MARINE PROBLEMQuarter Projects Week 4 – set up experiment; begin sampling Week 5 – continue sampling Week 6 – complete analysis; begin paper and/or power pointSemester Projects Week 4 – complete sampling Week 5 – begin and complete data analysis Week 6 – clean labYear-long Projects Week 4 – continue sampling Week 5 – begin and complete data analysis Week 6 – clean lab | MesopelagicThermohaline circulationGreat ocean conveyorThermoclineVertical migrationDeep scattering layerBioluminescenceOxygen minimum zoneBathypelagicAbyssopelagic (abyss)HadopelagicHermaphroditeChemosynthesisHydrothermal ventsCold seeps | SC.912.E.6.4 Analyze how specific geological processes and features are expressed in Florida and elsewhereSC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.910.4.2.2 The student will record information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Week 7 | Final Project PresentationsReview for semester exam | Written reports and power point presentations |  | SC.912.E.7.2 Analyze the causes of the various kinds of surface and deep water motion within the oceans and their impacts on the transfer of energy between the poles and the equatorSC.912.P.10.2 Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantitySC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, Moderate marine systems and terrestrial systems. SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycleMA.912.S.1.2 Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.MA.912.S.3.2 Collect, organize, and analyze data sets, determine the best format for the data and present visual summaries.LA.910.4.2.2 The student will record information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining) |
| Week 8 | **SENIOR SEMESTER EXAMS**  |  |  |  |
| Week 9 | **JUNIOR SEMESTER EXAMS** |  |  |  |

**Listed below are the ELA and Mathematics Florida Standards, which should be incorporated into the curriculum of this course.**

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| [MAFS.912.N-Q.1.1:](http://www.cpalms.org/Public/PreviewStandard/Preview/5519) | Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. |
| [MAFS.912.N-Q.1.3:](http://www.cpalms.org/Public/PreviewStandard/Preview/5521) | Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| [MAFS.912.F-IF.2.4:](http://www.cpalms.org/Public/PreviewStandard/Preview/5573) | For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* |
| [MAFS.912.F-IF.3.7:](http://www.cpalms.org/Public/PreviewStandard/Preview/5576) | Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.1. Graph linear and quadratic functions and show intercepts, maxima, and minima.
2. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
3. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
4. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
5. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude, and using phase shift.
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| [MAFS.912.G-MG.1.2:](http://www.cpalms.org/Public/PreviewStandard/Preview/5639) | Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot). |
| [MAFS.912.S-ID.1.1:](http://www.cpalms.org/Public/PreviewStandard/Preview/5641) | Represent data with plots on the real number line (dot plots, histograms, and box plots).

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| **Remarks/Examples:**In grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points. |

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| [MAFS.912.S-ID.1.2:](http://www.cpalms.org/Public/PreviewStandard/Preview/5642) | Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

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| **Remarks/Examples:**In grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points. |

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| [MAFS.912.S-ID.1.3:](http://www.cpalms.org/Public/PreviewStandard/Preview/5643) | Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

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| **Remarks/Examples:**In grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points. |

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| [MAFS.912.S-ID.1.4:](http://www.cpalms.org/Public/PreviewStandard/Preview/5644) | Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. |
| [MAFS.912.S-ID.2.5:](http://www.cpalms.org/Public/PreviewStandard/Preview/5645) | Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. |
| [MAFS.912.S-ID.2.6:](http://www.cpalms.org/Public/PreviewStandard/Preview/5646) | Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. 1. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear, and exponential models.*
2. Informally assess the fit of a function by plotting and analyzing residuals.
3. Fit a linear function for a scatter plot that suggests a linear association.

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| **Remarks/Examples:**Students take a more sophisticated look at using a linear function to model the relationship between two numerical variables. In addition to fitting a line to data, students assess how well the model fits by analyzing residuals. |

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| [MAFS.912.S-IC.2.6:](http://www.cpalms.org/Public/PreviewStandard/Preview/5655) | Evaluate reports based on data. |
| [LAFS.1112.SL.1.1:](http://www.cpalms.org/Public/PreviewStandard/Preview/6114) | Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively. 1. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
2. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
3. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.
4. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
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| [LAFS.1112.SL.1.2:](http://www.cpalms.org/Public/PreviewStandard/Preview/6115) | Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. |
| [LAFS.1112.SL.1.3:](http://www.cpalms.org/Public/PreviewStandard/Preview/6116) | Evaluate a speaker’s point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. |
| [LAFS.1112.SL.2.4:](http://www.cpalms.org/Public/PreviewStandard/Preview/6117) | Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks. |
| [LAFS.1112.SL.2.5:](http://www.cpalms.org/Public/PreviewStandard/Preview/6118) | Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. |
| [LAFS.1112.RST.1.1:](http://www.cpalms.org/Public/PreviewStandard/Preview/6195) | Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. |
| [LAFS.1112.RST.1.2:](http://www.cpalms.org/Public/PreviewStandard/Preview/6205) | Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. |
| [LAFS.1112.RST.1.3:](http://www.cpalms.org/Public/PreviewStandard/Preview/6206) | Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. |
| [LAFS.1112.RST.2.4:](http://www.cpalms.org/Public/PreviewStandard/Preview/6207) | Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics. |
| [LAFS.1112.RST.2.5:](http://www.cpalms.org/Public/PreviewStandard/Preview/6208) | Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. |
| [LAFS.1112.RST.2.6:](http://www.cpalms.org/Public/PreviewStandard/Preview/6209) | Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. |
| [LAFS.1112.RST.3.7:](http://www.cpalms.org/Public/PreviewStandard/Preview/6210) | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. |
| [LAFS.1112.RST.3.8:](http://www.cpalms.org/Public/PreviewStandard/Preview/6211) | Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. |
| [LAFS.1112.RST.3.9:](http://www.cpalms.org/Public/PreviewStandard/Preview/6212) | Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. |
| [LAFS.1112.RST.4.10:](http://www.cpalms.org/Public/PreviewStandard/Preview/6213) | By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently. |
| [LAFS.1112.WHST.1.1:](http://www.cpalms.org/Public/PreviewStandard/Preview/6242) | Write arguments focused on *discipline-specific content.* 1. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
2. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience’s knowledge level, concerns, values, and possible biases.
3. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
4. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
5. Provide a concluding statement or section that follows from or supports the argument presented.
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| [LAFS.1112.WHST.1.2:](http://www.cpalms.org/Public/PreviewStandard/Preview/6243) | Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. 1. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
2. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.
3. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
4. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
5. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
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| [LAFS.1112.WHST.2.4:](http://www.cpalms.org/Public/PreviewStandard/Preview/6244) | Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. |
| [LAFS.1112.WHST.2.5:](http://www.cpalms.org/Public/PreviewStandard/Preview/6245) | Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. |
| [LAFS.1112.WHST.2.6:](http://www.cpalms.org/Public/PreviewStandard/Preview/6246) | Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. |
| [LAFS.1112.WHST.3.7:](http://www.cpalms.org/Public/PreviewStandard/Preview/6248) | Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. |
| [LAFS.1112.WHST.3.8:](http://www.cpalms.org/Public/PreviewStandard/Preview/6249) | Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. |
| [LAFS.1112.WHST.3.9:](http://www.cpalms.org/Public/PreviewStandard/Preview/6250) | Draw evidence from informational texts to support analysis, reflection, and research. |
| [LAFS.1112.WHST.4.10:](http://www.cpalms.org/Public/PreviewStandard/Preview/6251) | Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. |

**APPENDIX A Assessing Student Designed Research**

Each section of the final paper is scored on a 0-4 scale based on the following:

4 = excellent work; all objectives met, concepts understood, no grammar issues

 3 = good work; most of objectives met, concepts basically understood, some grammar issues

 2 = adequate work; some objectives met, concepts not completely understood, some grammar issues

 1 = inadequate work; few objectives met, concepts basically not understood, grammar issues

 0 = no attempt; the student did not attempt this objective

|  |  |
| --- | --- |
| **Section of Final Project** | **Description** |
| Title | The title should be descriptive; proper capitalization; name(s) and date |
| Introduction | The introduction should first describe the observation that led to the question to be studied; there should be evidence of adequate background research as to what is already known about this topic and all research properly cited; there should be a supported hypothesis as to what they think will happen and why |
| Material and Methods | Material and methods explains to the reader HOW the data was collected; it should include – which species will be studied and why (if organisms are going to be used); where sampling will occur if it is in the field (include gogglemap and GPS) OR where samples were acquired if experiment is in the lab; what variables will be measured or monitored and what technology will be used to measure these; how often were measurements taken and how were they logged; if working in the lab with live animals – how were they housed and fed (include photos); state when the project began and ended |
| Data | All data tables are included here; tables should be correctly labeled and all units included |
| Analysis | The analysis section is where any work with the data was conducted; this would include such things as – central tendencies and standard deviation, graphs, testing for significance, calculating diversity, etc.  |
| Results | In this section the researcher basic explains what happen during the experiment; how many trials were conducted, what statistical analyses were done and what were the results, what the graphs basically suggest, etc.  |
| Discussion | In the discussion section the research discusses the results; do they support or reject the hypothesis? What trends were observed? Were there factors that occurred during the experiment that the reader should be aware of? Basically what did we learn from this?  |
| Acknowledgements | A short sentence or so thanking anyone and everyone who contributed to the success of this project |
| References | A well designed reference section that list all resources used in developing the back ground for the introduction and experiments used to design this one |
| Power Point Presentation | Good mix of text and images; did NOT read the power point; good color contrast (easy to read from the audience); well spoken – spoke at appropriate age group level – good verbal projection; answer questions well  |

MEAN SCORE: 4.0 – 3.5 = A

 3.4 – 3.0 = B The 0-4 scale can be used for any portion of the project in which the instructor wishes to assess in addition to the final paper and power point

 2.9 – 2.2 = C

 2.1 – 1.5 = D

 1.4 – 0.0 = F

 Marine Science 2

 Lab Program

The following labs were designed for both the average and the honor second year marine science student in Escambia County. In marine science 1 the student learned about the marine environment, the organisms that live there, how scientists sample the ocean and how they develop and report experiments. The first year student was also introduced to the basic technology, the study of the marine environment, and learned how to identify many of the different forms of life that live there. The second year marine science student will learn more about the ecology of marine systems; how the environment and the organisms interact with each other. It is assumed that the second year student is VERY interested in science and so this lab program is designed to teach them more advanced methods of data analysis. Students who complete this lab program will be better prepared to study higher levels of marine science in college or, at the very least, be better educated on how science works and develops policies that may affect everyone in our community.

The major difference between the HONORS and AVERAGE student labs in this program will be the level of statistics that the two groups will learn and use. The labs are designed so that these data analysis methods will be used over and over again; the ole “use it or lose it” idea.

Each of the labs is designed for a 4-week period (except the 2nd half of 3rd quarter there are two short labs – 6a and 6b). Students can work in teams or as individuals, whichever the instructor prefers. This lab program is designed so that the instructor will spend a minimum of 2 days / week on lab. Many of the labs require sampling in the field. These samples can be associated with a class field trip or at a location on campus, depending on the resources and time allotted for such activities at each high school.

Instructors certainly have leeway to modify any of the activities to fit their scheduled time and are more than welcome to submit suggestions for improvement to the science supervisor of Escambia County. This program is certainly a work in progress. ☺

**Lab #1 – Who Is Taller?**

 Marine Science Program – Escambia County, FL

Objective: The objective of this lab is to expand the student’s understanding of the scientific

process. In this lab data will be collected from students in the classroom and more advanced methods of data analysis will be taught.

Introduction Most students have noticed that as we move from elementary to middle school girls grow at a faster rate in their early years and are taller than the boys; but what about the time from middle school to high school? Have the boys begun to grow more? Are they actually taller now? In this lab we will measure the height from a sample of males and females from the general population at our school. We will analyze the data to determine if there is a difference in height between males and females and whether that difference is significant.

Method

1. We will measure 10 males and 10 females from the general population. The question is *how are we going to select those 20 individuals*? You want to avoid experimental *bias* when selecting these individuals and there are basically two methods that can be used; **systematic** or **random** sampling. Systematic would use a “system” approach to selecting (every 3rd name for example). Random is just that… there is no system to how they were selected, it is totally random. The class will first have to decide which method they are going to use and then how they will use this method. So, select 10 males and 10 females from your class to be measured.
2. How are you going to measure their height? What units of measurement will you use? Are there any variables other than the fact that they are male or female that could affect the results of your measurement? (age or shoe type for example). Once this has been decided measure your 20 students (remember significant figures in your measurement).

Analysis

1. First we need to determine the “central tendency” for both sexes (how tall most of the population of each sex would be). The method to be used here would be to determine the mean height; so, calculate the mean height of your males and females.
2. Next in a “normal” population 68% of the sample should be within ± 1 standard deviation (SD) from the mean (see next page on how to determine standard deviation). If 68% are within 1 SD then the mean is a true representation of how tall a high school male or female is; if not, then the data is skewed in some way. Is your data “normal” or is it skewed?
3. If it is skewed then look at the entire sample. 99% of the sample should be within ± 3 SD. Do you have anyone in your sample that is greater or less than ± 3 SD? If so, this is what we call an **outlier**. You have two choices now… remove this datum from the sample OR measure more students and re-calculate the mean and SD. If everyone is within 3 SD move on… if not, decide how you will handle this problem.
4. If 68% of your data is within ± 1 SD or 99% within ± 3 SD compare the heights; are the females still taller than the males? Are they about the same height? Are the males taller?
5. **HONORS CLASSES –** Let’s say there IS a difference in height… is there a *significant* difference in height? To understand this concept lets take the idea that Gregor Mendel suggested that the sex ratio of males to females is 50:50 (1:1). If you count the males and females in the class and find that the ratio is actually 49:51 does this mean that Mendel was a quack and the rule does not apply OR is this close enough? If you believe it is close enough for the rule to be good what about 48:52? How about 47:53? How much of a difference is ENOUGH for us to say Mendel was wrong? Well… we can measure **significant difference** by either using a mathematical model called the **Chi-square (x2)** or the **T- test**. Chi-square is used if you have an expected outcome (i.e. a 50:50 sex ratio). The t-test is used when you want to compare two populations but you do not have an expected outcome; as in our case here. HOW to calculate “t” and eventually find “p” (the probability that the difference is due to chance) is explained on the next page.

**Calculating Standard Deviation**

1. Determine the mean of the sample
2. Subtract the mean from each value in the sample
3. Square the difference calculated from #2
4. Calculate the sum of the values found by doing #3
5. Divide the sum found in #4 by the number of individuals in the sample less one (n-1); ***this is known as the variance and will be needed to determine your “t” value in honors classes***
6. Take the square root of the value you calculate in #5; **this is the standard deviation ☺**

Example:

(n=10)

Sample (ni) (ni-x) (ni-x2)

6 1 1

4 -1 1

5 0 0

7 2 4

2 -3 9

4 -1 1

7 2 4

3 -2 4

9 4 16

6 1 1

Mean (x) = 5 Σ (ni-x2) = 41

 Σ/(n-1) = (41/9) = 4 ***this is how to determine the variance (s2) needed for t-test***

 √ s2 = √ 4 = 2

Mean = 5 ±2 SD = ± 2 68% ± 1SD = 2 = between (3-7) – in example = 80%

 99% ± 3SD = 6 = between (0-11) – in example = 100%

 ***Data not skewed***

**Calculating the t-test**

*IF the number of individuals in each sample is the same:*

 t = (x1 – x2) / √ { (s21 + s22) / n} x1 = mean from sample one; s21 = variance of 1

 x2 = mean from sample two; s22 = variance of 2

 n = number of individuals in each sample

1. calculate “t”
2. determine the “degree of freedom” in the samples; df = (n1 + n2) – 1. Let’s say you have 10 individuals in each sample. (10+10) -1 = (20)-1 = 19; df =19
3. use the “probability chart” to determine whether the difference between the two samples is significant. Most use the “p = 0.05” as the cut-off point for this. See following example

Example:

Sample 1 - n = 10, x1 = 5, s2 = 4

Sample 2 - n = 10, x2 = 2, s2 = 2

t = (5-2) / √ (4+2) / 10

t = 9.037

df = 19

Now take the “t” value and the “df” value and find “p” using the following chart.

**Distribution of *t* Probability**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Df** | **0.1** | **0.05** | **0.01** | **0.001** |
| 1 | 6.314 | 12.706 | 63.657 | 636.619 |
| 2 | 2.920 | 4.303 | 9.925 | 31.598 |
| 3 | 2.353 | 3.182 | 5.841 | 12.941 |
| 4 | 2.132 | 2.776 | 4.604 | 8.610 |
| 5 | 2.015 | 2.571 | 4.032 | 6.859 |
| 6 | 1.943 | 2.447 | 3.707 | 5.959 |
| 7 | 1.895 | 2.365 | 3.499 | 5.405 |
| 8 | 1.860 | 2.306 | 3.355 | 5.041 |
| 9 | 1.833 | 2.262 | 3.250 | 4.781 |
| 10 | 1.812 | 2.228 | 3.169 | 4.587 |
| 11 | 1.796 | 2.201 | 3.106 | 4.437 |
| 12 | 1.782 | 2.179 | 3.055 | 4.318 |
| 13 | 1.771 | 2.160 | 3.012 | 4.221 |
| 14 | 1.761 | 2.145 | 2.977 | 4.140 |
| 15 | 1.753 | 2.131 | 2.947 | 4.073 |
| 16 | 1.746 | 2.120 | 2.921 | 4.015 |
| 17 | 1.740 | 2.110 | 2.898 | 3.965 |
| 18 | 1.734 | 2.101 | 2.878 | 3.922 |
| 19 | 1.729 | 2.093 | 2.861 | 3.883 |
| 20 | 1.725 | 2.086 | 2.845 | 3.850 |
| 21 | 1.721 | 2.080 | 2.831 | 3.819 |
| 22 | 1.717 | 2.074 | 2.819 | 3.792 |
| 23 | 1.714 | 2.069 | 2.807 | 3.767 |
| 24 | 1.711 | 2.064 | 2.797 | 3.745 |

 With a “df” of 19 and a “t” of 9.037 in our example you would find 19 in the “df” column and slide to the right until you found the number 9.037. In this case this goes off the chart so we would say that “p” = > 0.001. This means that the probability that the difference between the two samples is due to chance (or insignificant) is greater than 1/1000. In other words the difference is NOT due to chance… there is a significant difference. This would be recorded in your report as follows: *we find there WAS a significant difference between the mean height of the males and females (p = > 0.001) and the boys are significantly taller in high school than the girls.*

“In general” most researchers use 0.05 as the cut-off for degree of significance; meaning for any particular “df” value if the “t” value is at 0.05 or smaller (to the right in this chart) there IS a significant difference between the two samples.

ENJOY ☺

**Lab #2 – Sampling Plankton in the Marine Environment**

Objective: The objective of this lab is to learn how to sample plankton from the marine environment and study the diversity and abundance within a sample.

Introduction: You learned in Marine 1 that plankton are drifting or floating organisms within the water column of the marine environment. We understand their importance to biological productivity in the ocean and that in some systems they may be the sole source of primary production. As their numbers shift so goes the valuable marine fisheries that many depend on. In this lab we will first learn how to sample plankton from the ocean and then how to determine certain metrics that are used by marine biologists interested in biological productivity and fisheries. Methods similar to these could be used to determine the impact of the 2010 Deepwater Water Horizon Oil Spill on marine life in the Gulf of Mexico.

Method

1. We must collect plankton. To do this you will need a plankton net. This net can either be towed behind a boat by the instructor, or hung off of an extended dock or bridge on a field trip for the class. If the net is to be towed behind a boat the researcher will need to record **the distance** over which the tow occurred. If they are hanging the net from a bridge and collecting with the current or tide, they will need to record the time in which the net was in the water, the width of the bridge (m) and the time it takes an object to drift under the bridge (min). Samples should be placed in sealed sample jars and kept on ice. Samples can be collected from different locations or at the same location on different days. Be sure to log all information on time and location when sampling. Check data sheet (pg. 2) for other variables to be measured while sampling.
2. Calculate the total volume of water sampled as follows:

a) Towed behind boat cubic meters (m3) = (πD2)L / 4 D = diameter of net (meters)

 L = length of tow (meters)

b) Hung from bridge length of tow (L) = {(Ti)(W)} / t Ti = length of time in water (min)

 W = width of dock/bridge (m)

 t = time it took for a floating

 object to pass bridge (min)

 Cubic meters (m3) = (πD2)L / 4

c) convert your answer from m3 to ml; record both in the data table

3. What is the concentration of **macroscopic** plankton in your sample (we will exclude

**microscopic** from the sampling process in this lab)?

* 1. determine the volume of sample you received at your desk (ml); record this
	2. determine the area of your Petri dish area (cm2) = πD2 / 4
	3. place the petri dish over a centimeter grid or graph paper with cm squares clearly marked; pour your sample into this dish
	4. determine a method of randomness and randomly select five centimeter squares and count all of the macroscopic organisms in each. Record both the total and average number of macroscopic plankton in your sample.
	5. Estimate the population of macroscopic plankton in your dish using the following:

T = (t)(A) / g t = total count from the five random cells

 A = area of petri dish (cm2)

 g = the number of grids counted

 T = is the # of macroscopic plankton / ml of sample

Record this value

* 1. Determine the total number of macroscopic plankton in the entire sample collected by doing the following:

Q = (T)(V) / v T = total number of plankton in YOUR sample

 V = total volume of ENTIRE sample collected

 v = volume of YOUR sample

4. Identify and record the more common species found in the data table

**PLANKTON LABORATORY**

**Data Sheet**

|  |  |  |
| --- | --- | --- |
| **Date:** | **Location:** | **Time:** |
| **Tide:** | **Depth:** | **Tow time:** |
| **Mesh size:** | **Net diameter (m):** | **Tow distance (m):** |
| **Vol of sample (ml):** |  | **Vol of lab sample:** |
| **Common organism #1** |  |  |
| **Common organism #2** |  |  |
| **Common organism #3** |  |  |
| **Common organism #4** |  |  |
| **Common organism #5** |  |  |
| **Common organism #6** |  |  |
| **Vol water passed through net:** |  |  |
| **# of macros in your sample:** |  |  |
| **# of macros in total sample:** |  |  |

**REPEAT SAMPLING IN ANOTHER LOCATION – OR – AT THE SAME LOCATION ON A DIFFERENT DAY; COMPARE THE RESULTS; SUGGEST A REASON FOR ANY DIFFERENCE OBSERVED**

**Lab #3 – Measuring Seagrass Productivity**

Marine Science Program – Escambia County, FL

Objective: The primary objective of this lab is to learn how to set up a field study and measure the status of a plant ecosystem.

Introduction: Marine biologists have been reporting for a few decades that seagrass meadows in the Gulf of Mexico have been declining. There have been several hypotheses as to why but the concern is the variety of commercially valuable marine species that use these meadows as nursery grounds and how the decline of these meadows will impact their populations. In this lab we will use a method used by many field biologists to determine the state of a particular taxa of plant; this is called the **Braun Blanquet** model.

Method:

1. Select a plant habitat to measure. If you can make a field trip, you can do a seagrass meadow or salt marsh (marine plant environment). If this is not possible, you can select an area on your campus to monitor (terrestrial plant environment).
2. Once you have selected the monitoring location you will place a 50-meter transect down within this habitat; the location you select can be chosen either randomly or systematic – decide on one and select your monitoring location.
3. You will need a 0.5 meter quadrat subdivided into 10-cm sections. You can make the 0.5-m quadrat from PVC, drill small holes in the four sides of this quadrat and run string through these holes to make the 10-cm sections. At 5 meters along the 50-m transect lay the 0.5m quadrat down and determine the **Braun Blanquet density score** by using the table below. If you are monitoring a seagrass bed you can measure the density of either Shoal grass (*Halodule wrightii*) or Turtle grass (*Thalassia testidinum*) or both (seagrass density in general)… your call. If you are monitoring a salt marsh you have the choice between Cordgrass (*Spartina alterniflora*), Needlerush (*Juncus romarianius*), or both. If you are monitoring a site on campus select a species that you have there. Repeat every 5m to the end of the transect. You should have a total 10 samples / transect.
4. Record the MEAN and MODE Braun Blanquet score for this transect in your lab book.
5. Repeat this process along another transect at the same location or move to a new location and repeat (USE SAME PLANT TAXA EACH TIME).

Analysis

1. Produce a frequency plot of the different Braun Blanquet scores for each transect your do. How do the different samples compare?
2. Determine the standard deviation of each MEAN.
3. **HONORS ONLY –** Using the MEAN and VARIANCE values you calculated, use the **t-test** to determine whether the difference between the two locations (or transects at the same location) are significantly different.

Results

1. Based on these transects would you say that the plant taxa you scored are abundant or not? Defend your answer.

|  |  |
| --- | --- |
| **Table 1.** | **Braun Blanquet density score** |
| **Score** | **Coverage** |
| 0 | Taxa absent from quadrat |
| 0.1 | Taxa represented by solitary shoot, <5% coverage |
| 0.5 | Taxa represented by a few (<5) shoots, <5% coverage  |
| 1 | Taxa represented by many (>5) shoots, < 5% coverage |
| 2 | Taxa represented by many (>5) shoots, 5-25% coverage |
| 3 | Taxa represented by many (>5) shoots, 25-50% coverage |
| 4 | Taxa represented by many (>5) shoots, 50-75% coverage |
| 5 | Taxa represented by many (>5) shoots, 75-100% coverage |

**Lab #4 – Analyzing a Fiddler Crab Colony**

Objective: The primary objective for this lab is to practice the more advanced methods of statistics the students have been learning in this course.

Introduction: Fiddler crabs (*Uca sp.*) were selected for this lab because they are abundant in many salt marsh locations and it is easy to collect many so that you have a good population sample, they are also a marine animal ☺. But you may find that this is not the case with your class and can certainly modify this lab to include another species. Be sure to select a species that has some phenotypic adaptation that can be compared within the population and that you can tell the males from the females (*sexually dimorphic*).

 Fiddler crabs are a common member of the salt marsh community. They dig small burrows near the tide line whereever a sandy beach meets the waters edge within the marsh. These small shoreline crabs are easily identified by the fact that males possess one large chela (claw) which they use to attract females and drive away revival males. They come out of their burrows during low tide to feed on organic detritus in the sand producing small round balls called *pseudofeces.*  Most fiddler colonies are quite dense and selecting a large number of individuals to analyze should be easy. They are totally harmless so don’t worry about their bite, not much really ☺

Method:

1. You will need about 50 fiddler crabs for each class. You will need to set up a lab habitat for each group of 50. A wide storage tub with a layer of moist (with brackish water) sand should work fine. Be sure to have high walls so that the fiddlers do not escape. If you are going to keep them in the lab for a long period you may have to design a better habitat. They seem to do fine with dry dog food during the course of this experiment.
2. You will need to decide how you are going to sample your population; there can be 1000’s of fiddlers within a colony. Of course you have two methods to choose from; random or systematic. Once you have decided how your class will sample the population, and you have your lab habitat ready, it is time to collect the crabs. This can be done as a class field trip or by the instructor.
3. Design a data table that will include the following metrics: sex, length of chela in mm (larger chela if male, either for the female), whether the male’s are “right” or “left” handed (based on larger chela), and mass in gm. You can split the crabs between lab groups in the class. Return ALL crabs to the lab habitat ALIVE and in GOOD SHAPE ☺

Analysis:

1. Calculate and graph the distribution of sex within this colony
2. Calculate and graph the MEAN length and ±SD of male and female chela
3. Calculate and graph the MEAN mass and ±SD of males and females
4. Produce a frequency distribution of mass and length data
5. Determine the number of “right” and “left” handed males and what percent of males in this sample are “right-handed”

Discussion:

1. What is your opinion on the accuracy of the non-bias sampling your class did? If you thought it needed improvement, how would you do this?
2. What are some possible limitations of this study?
3. Did you find the (50:50) male / female distribution that is expected? If not, which sex was favored? Why do you think you captured more of those?
4. Was there any correlation between: sex and mass? Chela length and mass?
5. Do you feel this was a good representation of what you would expect to find in any local *Uca* population? Why or why not?

**Lab #5 – Reproductive Behavior of Local Marine Animals**

 Marine Science Program – Escambia County, FL

Objective: This lab is more of an observation lab than anything else. The real objective here is the better understand reproductive behavior.

Introduction: All creatures must reproduce in order to sustain their species. In most marine species males and females have little to do with each other over the course of the year but when breeding season begins, they can think of little else. As a matter of fact many species migrate great distances to spawning grounds during mating season. So our question here is what stimulates reproductive behavior in marine animals? This information is not only useful to marine biologists who are interested in the topic of reproduction but to fish farmers who might want their fish stock to reproduce more than one time a year, or an environmental scientist trying to understand whether the decline of a particular marine animal was due to some sort of environmental change caused by humans.

Method:

1. We must first select a species for study… you are going to need an animal that is (a) easy to find – even in colder weather, (b) is sexually dimorphic (you can tell the male from the female), and (c) produces eggs in a short period of time. Do some research and decide as a class which species you will use.
2. How are you going to collect them? How are you going to house them? What are you going to feed them? Animals that are stressed will probably not reproduce – make their world as close to natural as you can. Allow an acclimation period (maybe 2 weeks) before you begin.
3. How are you going to tell if mating occurred?
4. Do research to determine what *may* stimulate this species to reproduce; monitor these parameters as the experiment continues. Include in your parameters salinity, temperature, dissolved oxygen, a photoperiod. Decide what your photoperiod will be for this experiment. Be sure to log if your team decides to change this during the experiment.
5. This experiment may run the rest of the semester; maybe the rest of the year.

Results:

1. How many males did you begin with? How many did you have at the end?
2. How many females did you begin with? How many did you have at the end?
3. What was the MEAN water temperature within the tank during the experiment (be sure to calculate ±SD). Was there any variation within the temperature? If so did the variation stimulate reproduction? Defend your answer.
4. Repeat #3 for salinity, dissolved oxygen, photoperiod, and any other parameter your research suggested you monitor.
5. How many eggs were produced during this experiment? How many eggs / mating pair would this be? Were eggs laid at an equal rate during the experiment or at staggered times?
6. What behavior patterns did you observe in the males during the experiment?
7. What behavior patterns did you observe in the females?

***Produce a table similar to the one below in a data logbook. Again, this may take a long time to complete***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Date** | **Temp (˚C)** | **Salinity (‰)** | **DO2 (ppm)** | Other parameters | **# of males** | **# of females** | **# of eggs** | **Behavior** |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| SUM |  |  |  |  |  |  |  |  |
| AVG ±SD |  |  |  |  |  |  |  |  |

**Lab # 6a – Estimating Population Numbers in the Marine Environment**

 Marine Science Program – Escambia County, FL

Objective: The primary objective of this lab is to teach the student one field method used to estimate the population of a management species. The tag and recapture method is commonly used for very motile species which are difficult to conduct direct counts of.

Introduction: Sea turtles are one of the more popular marine organisms in Florida. People from the age of 1 to 92 love to see the adults lay eggs, the hatchlings run towards the ocean, and the different species swimming in the open water. There is concern in marine biology about the future of this reptile. Of the seven known species all are listed as either endangered or threatened. To determine the rate of population decline, what the problem may be, and which management method to use marine biologists need to know how many turtles currently exist in a given area; the problem is how do you count an animal that covers thousands of miles of ocean and you can not be sure you have not already recorded an individual? One method used by field biologists around the world is the **mark – recapture** method. In this method, you tag a known number of individuals, release them, and then repeat the same sampling protocol for several years recording the number of animals you capture and how many of those have your tag (recaptures); marking new individuals each season you conduct the study. Let’s do an exercise where you will simulate what a mark-recapture study would be like if we were interested in the number of sea turtles in the Gulf of Mexico.

Method:

1. We know which species we are going to study, sea turtles, of course there are different species of sea turtles so you would have to limit your study to one particular one. You will also have to develop a method of marking this turtle so that (a) it does not harm the turtle, (b) can be easily seen by humans who may capture them, (c) not hinder the turtles normal daily behavior (i.e. make it hard for them to swim or dive, etc.), and (d) not make them an easy target for their predators (sharks). You and your lab mates decide on a method of marking these turtles and record your method in your lab.
2. Next you have to design a method to capture sea turtles. You will need a lot of individuals to make the tagging project effective but you do not want to kill any animals. You and your lab mates should now decide how you are going to capture at least 20 individuals each sampling trip. Record your method in the lab report.
3. Let’s say in our first trip (May, 2012) you capture 20 individuals and mark them using the method you developed earlier in this lab. These 20 individuals are the **black** **beans** at your table (n=20). The **white beans** in the can at your table represent the total population of sea turtles in the Gulf of Mexico (including the 20 marked ones). Place the 20 “tagged” turtles into the can with the others. Shake the can to mix the individuals equally.
4. Second trip (June, 2012) you return and use the SAME method you used in May to capture the original 20. You are now going to capture 20 individuals and record how many are tagged and how many are not. **RANDOMLY** select beans from the can – DO NOT CHEAT ☺ NO EXPERIMENTAL BIAS SHOULD OCCUR. Record how many from this sample are marked and how many are unmarked. Record these in the data table. Replace the “white beans” (unmarked turtles) with black beans indicating that you marked them and then place your “turtles” back into the can (Gulf); ALL animals are released each sample.
5. Future trips: July, 2012; August, 2012; September 2012. Repeat the same process for each sample – randomly select 20 “turtles” and record how many were marked and how many were not. Record these in the table, replace all new turtles (white beans) with marked turtles (black beans) and “release your turtles” each time.

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **# of Marked Turtles** | **# of Unmarked Turtles** | **Estimated Population** |
| June | 20 | NA | NA |
| July |  |  |  |
| August |  |  |  |
| September |  |  |  |
| **MEAN** |  |  |  |
| **± SD** |  |  |  |

Analysis:

1. Using the following math equation determine the population for each month you sampled. Record these values in the data table. Calculate the MEAN ±SD for the number of marked turtles captured, and unmarked for the entire study. Use these MEANS to calculate your estimated population of sea turtles in the Gulf.

**P = { (u + r) / r } m U = the number of unmarked turtles captured**

 **R = the number of marked turtles captured**

 **M = the number of marked turtles from the previous season**

1. How many turtles (based on the MEAN) are there in the Gulf of Mexico?
2. What was your highest estimate (comparing monthly samples)?
3. By looking at the number of beans in the can; do you think this estimate is pretty accurate?
4. NOW ☺ pour ALL of the beans in the can into a tray and (using your lab partners to help) count how many beans are REALLY there (the TRUE population). Calculate your percent error using the following equation:

**% error = { (O-E) / E} x 100 O = actual number of turtles in Gulf**

 **E = your estimated population based on MEAN**

 **RETURN BEANS TO CORRECT CANS (BLACK) AND (WHITE) NO MIXING ☺**

Discussion:

1. Have each lab group record their estimated population on the board and their % error.
2. Is this method pretty accurate for estimating populations? If not, how could it be improved?

**Lab # 6b – Are Manatees Populations Recovering in the State of Florida**

 Marine Science Program – Escambia County, FL

Objective: The primary objective of this lab is to yet again practice analyzing data. The data in this case are the actual manatee populations in the state of Florida between 1991 and 2004.

Introduction: A major part of understanding the ecology of a species is to know how many are currently in the population and what the recruitment rates are. These data are important to marine biologists who are interested in the general biology of the species, wildlife managers who are interested in whether or not the population is declining and whether or not protective management measures are needed to maintain the stock, and to wildlife lovers… who just like to keep a few species around for the future ☺ We are NOT going to learn how to determine the number of individuals within a population, we did this in LAB 6a with sea turtles. Rather we are going to take a set of data collecting in Florida between 1991 and 2004 and determine whether or not management put into place during the 1970’s is actually working.

Method

1. Study the data table of manatee population estimates below so that you understand it.
2. Produce one graph of the manatee population change from 1991 to 2004. Should you use a line graph or a bar graph? Why? Be sure to label the graph correctly (assessing graphing skills ☺).
3. Calculate the MEAN ±SD of the number of manatees counted between 1991 – 1997
4. Calculate the MEAN ±SD of the number of manatees counted between 1998 – 2004
5. **HONORS CLASSES ONLY –** using the “t-test” you learned earlier this year, determine of the difference in manatee numbers is ***significantly*** different between (1991-1997) and (1998-2004).

Results

1. What does your graph suggest is happening to manatee populations between 1991 – 2004?
2. How many population counts were conducted between 1991-1997?
3. How many population counts were conducted between 1998-2004?
4. Was there a difference in the number of manatees counted between (1991-1997) and (1998-2004)? **Honors Only -** If so, was this difference significant?
5. Are the management plans put into place by the state of Florida to protect the manatee working? Defend your answer

**Number of Manatees Counted in Population Study**

|  |  |  |  |
| --- | --- | --- | --- |
| **(1991 – 1997)** |  | **(1998 – 2004)** |  |
| **Date** | **No. of Manatees** | **Date** | **No. of Manatees** |
| Jan 23-24, 1991 | 1268 | Jan 29-30, 1998 | 2022 |
| Feb 17-18, 1991 | 1465 | Jan 6, 1999 | 1873 |
| Jan 17-18, 1992 | 1856 | Feb 23, 1999 | 2034 |
| Jan 21-22, 1995 | 1443 | Mar 6, 1999 | 2353 |
| Feb 6-7, 1995 | 1822 | Jan 16-17, 2000 | 1629 |
| Jan 9-10, 1996 | 2274 | Jan 27, 2000 | 2222 |
| Feb 18-19, 1996 | 2639 | Jan 10, 2001 | 3276 |
| Jan 19-20, 1997 | 2229 | Mar 1, 2002 | 1796 |
| Feb 13, 1997 | 1709 | Jan 9, 2003 | 2881 |
|  |  | Jan 21-24, 2003 | 3113 |
|  |  | Feb, 2004 | 2568 |

**Lab #7 – Using Ecological Metrics to Assess the Status of a Community**

 Marine Science Program – Escambia County, FL

Objective: The objective of this lab is to teach the student how to calculate and interpret basic ecological metrics used in determining the productivity and diversity within a particular community or ecosystem.

Introduction: Not all communities and ecosystems are created equal but there are a few things that all systems should have. There should be a variety of trophic levels and diversity within each of these levels. A decline in any of the above could be a warning sign of an ecological problem. When studying the ecology of a system it is important to know how much life (biomass) there is, which trophic levels are present and the population status of each level (pyramid), and the overall variety of creatures in the system (diversity). In this lab we will collect a sample from a system and measure the above metrics. If time permits we will resample at a different location and compare.

Method:

1. First we must decide which system we are going to study. This can be a marine system and the sampling take place during a field trip or a system on campus. Your class will need to make this decision.
2. Next, we need to know the area of which we are sampling. The area can be randomly or systematically selected. The area can be marked off with PVC or simply measured and sampled. You will need to record the sample area (m2) in your lab notes.
3. Now we will need to decide how to sample from this area. If in the marine environment, a seine net works well. You will need to decide how many “drags” you will make in this area. All creatures collected should be kept on ice and surveyed in lab ASAP. If you are collecting from an area on campus you will need to think of another method of how you will collect within this area.
4. IN LAB – sort the sample by lab groups; then each lab group should sort their sample by plant and animal. After they have completed this they should sort the plants and animals by species (they do not need to know the names). Once they have sorted by species each lab team should move from group to group and begin placing all similar species together.
5. Once this is completed count the total number of individual plant species in the sample; record this on the board. Then count the number of individual animal species and do the same. Everyone should record the class data into their lab notebooks.
6. Now find a tray (bucket) that will hold ALL of the sample (or one that will hold a lot of it ☺) and weigh this tray (bucket). Weigh the entire sample and record this in the lab book as the **wet weight**. Place in a fume hood and dry out over night. If you classroom does not have a fume hood, develop another SAFE method of drying the sample. Record the **dry mass**.
7. IF time permits, repeat with a 2nd sample from another location (or same if you wish ☺) for comparison.

Analysis:

1. Let’s first calculate the **Biological Diversity Index**. The closer the value is to 1.000 the more diverse the sample is.

**BDI = total # of species in sample (n) / Σ of number of individuals in a species2 (a,b,c, etc.)**

**BDI = (n) / (a2 + b2 + c2…) example: 143 total species / (3 pinfish)2 + (23 hermit crabs)2**

1. **HONORS ONLY –** Many marine biologists use the **Shannon Index** when calculating diversity. Here is how it is calculated: **SI = 3.322 [ (logΣni) – (Σ(ni x logni) / Σni]**

ni (logni) (ni x logni)

50 1.699 84.950 SI = 3.322 [ log(100) – 149.831 / 100]

35 1.544 54.044 SI = 3.322 [2 – 1.498]

7 0.845 5.916 SI = 3.322 [0.502]

5 0.699 3.495 SI = 1.668

3 0.477 1.431

100 149.831 = Σ

 *With the Shannon Index, the higher the value – the more diverse the system*

1. Now let’s calculate the **Biomass** (gC / m2); to do this simply subtract the dry mass you measured in class by the wet mass. This is the gC for the area you measured. If your area was not a m2 then you will need to convert to m2 before recording final biomass.
2. Finally we are going to construct a *SIMPLE*  **Food Pyramid** for this system. First we need to know the total number of individuals plants (ALL SPECIES COMBINED) for your sample. Next do the same for animals (ALL SPECIES TOGETHER – do not separate by species). Now draw a rectangle that is 2cm tall and 25 cm wide; this is the base of your food chain (the total number of producers in the system). To determine the size for your consumers (animals) use the following: rectangle width = ( # of consumers x 25cm) / # of producers. The height of you consumer block is still 2cm. Draw the pyramid.
3. REPEAT ALL OF THE ABOVE WITH THE SECOND SYSTEM FOR COMPARISON.

Discussion

1. Do you believe this exercise showed you what the diversity and abundance of this system truly is? Defend your answer
2. IF you did compare two (or more) systems; how did they compare? Which system was more diverse? Productive? Why do you think that system was more productive and diverse?

**Lab #8 – Inventory and Monitoring an Environmental Problem**

 Dr. Rick Kastner; Institute for Marine Mammal Studies – Gulfport MS

Objective: The primary objective of this lab is to understand the importance of conducting baseline surveys so that marine biologists can better determine how marine ecosystems are handling both human and natural catastrophes.

Introduction: Over the years marine biologists have observed drastic population changes over short periods of time that ask the question of the cause? Are they **anthropogenic** (human caused)? The National Oceanic and Atmospheric Administration (NOAA) has conducted many population surveys over the years so that there are baseline data to compare to when determining whether the population change being observed would be considered catastrophic or not. They particularly have good data on shrimp, blue crab, bottlenose dolphin, oysters, fish, sea turtles, and shore birds. In this lab the student will simulate a summer population survey and compare the results to the NOAA baseline data. From this they should be able to use a data table indicating population change and which event may have caused the population shift.

Method:

1. Below are icons that represent the major marine species that NOAA has baseline data on and how many of those individuals each icon represents. Study these so that you will understand the rest of the lab.
2. Below the icons are the baseline numbers for each of these species collected by NOAA
3. Below the baseline data is the sample during a summer where a catastrophic event occurred (**Event #1**). Calculate the percent loss in each of the baseline groups; Using the following rubric score each species % loss with the letter assigned and place this in table 1. **A = (0%) no decline or loss at all**

**B = (1-10%) mild loss**

**C = (11-20%) moderate loss**

**D = (21-100%) severe loss**

1. Using table 2 determine what the catastrophic event was; record.
2. Repeat the process for **Event #2, Event #3**.

**ICONS USED FOR DIFFERENT SPECIES IN THIS LAB**:

Ω = 1,000,000 shrimp Φ = 1,000,000 fish

Ψ = 1,000,000 crabs β = 1,000 sea turtles

Θ = 10,000 bottlenose dolphin π = 1,000 shore birds

Ђ = 100,000 bushes of oysters

**NOAA BASELINE NUMBERS FOR EACH SPECIES**:

Ω Ω Ω Ω Ω Ω Ω Ω Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ

Ψ Ψ Ψ Ψ Ψ Ψ Ψ β β β β β β β β

Θ Θ Θ Θ Θ Θ Θ Θ π π π π π π π π π π

Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ

**Table 1. Results of Your Sampling for Events (1-3)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Event** | **Shrimp** | **Crab** | **Dolphin** | **Oysters** | **Fish** | **Sea Turtle** | **Shore birds** |
| #1 |  |  |  |  |  |  |  |
| #2 |  |  |  |  |  |  |  |
| #3 |  |  |  |  |  |  |  |

**Table 2. Degree of Devastation Based on Monitoring Studies**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Event** | **Shrimp** | **Crab** | **Dolphin** | **Oysters** | **Fish** | **Sea Turtles** | **Shore birds** |
| Hurricane | D | **C** | **A** | **B** | **B** | **C** | **B** |
| Acute Oil Spill | **D** | **D** | **C** | **D** | **D** | **D** | **D** |
| Severe Cold Front | **A** | **A** | **A** | **A** | **A** | **C** | **A** |
| Red Tide | **A** | **A** | **A** | **A** | **C** | **A** | **A** |
| Shrimping Activities | **D** | **C** | **A** | **A** | **C** | **C** | **A** |

**EVENT #1 –**

Ω Ω Ω Ω Ω Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ

Ψ Ψ Ψ Ψ β β β β β β

Θ Θ Θ Θ Θ Θ Θ π π π π π π π

Ђ Ђ Ђ

**EVENT #2 –**

Ω Ω Ω Ω Ω Ω Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ

Ψ Ψ Ψ Ψ Ψ Ψ β β β β β β

Θ Θ Θ Θ Θ Θ Θ Θ π π π π π π π π π

Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ

**EVENT #3 –**

Ω Ω Ω Ω Ω Ω Ω Ω Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ Φ

Ψ Ψ Ψ Ψ Ψ Ψ Ψ β β β β β β β β

Θ Θ Θ Θ Θ Θ Θ Θ π π π π π π π π π π

Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ Ђ

Discussion:

1. What were the three different catastrophes in the order they occurred; what impact did these events have?
2. Discuss how these three different events would actually cause problems for the above groups; i.e. did this event deplete oxygen? Etc.