

Oceans Apart

Critical Thinking Design Elements in Marine Ecology

Michael Childress
Biological Sciences

A woman with long blonde hair, wearing a patterned blue and white shirt, is shown in profile from the chest up, looking out towards the ocean. The background is a bright, hazy sunset over the water, with some buildings visible in the distance. The overall mood is serene and contemplative.

CORAL CRUSADER

By **JIM MELVIN**
Photography By **JESSE GODFREY & MADISON WILLIAMS**

Coral reefs in the Florida Keys, Caribbean and throughout the world are in dramatic decline. A graduate student from Clemson has made it her mission to help restore one of the ocean's most endangered and invaluable species.

IN THE WATERS OF THE FLORIDA KEYS, just above the ocean floor, a young woman raises a hammer and strikes the head of a steel bar. The force of the blow drives her backward. She struggles to regain her position and strikes again. And again. Finally, she's satisfied that it's securely in place, holding down a PVC frame on the ocean floor. However, there are at least 40 more steel bars to slam home before she and her team can call it a day.

VOYAGE TO THE BOTTOM OF THE SEA

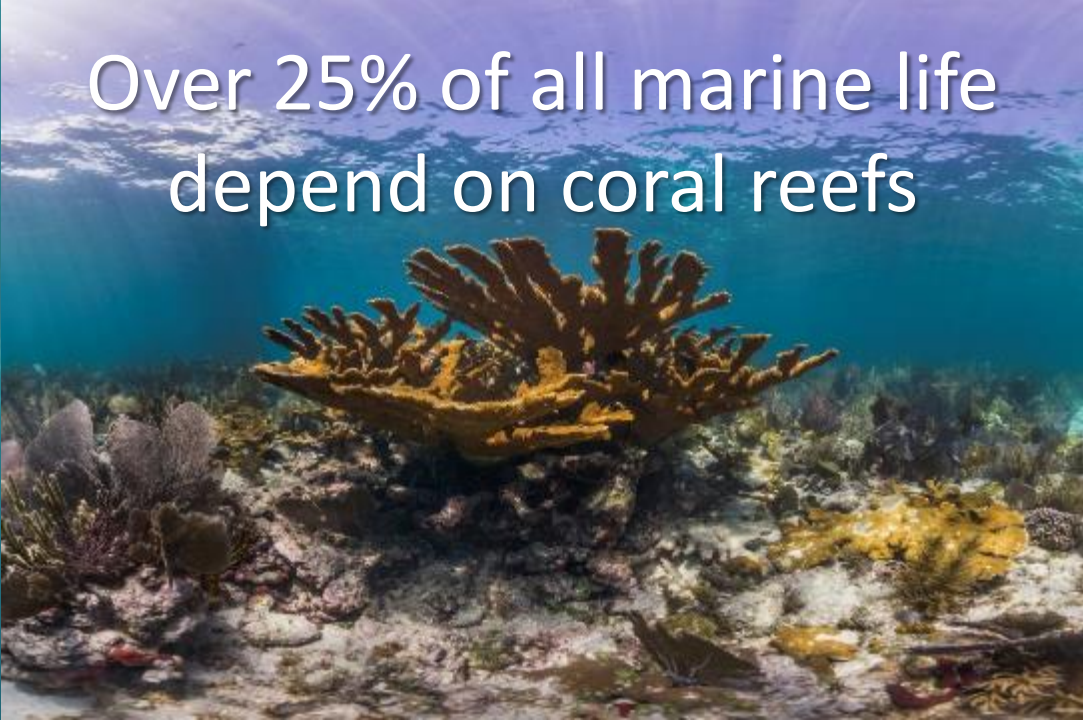
IN SO MANY WAYS, IT'S A LONG JOURNEY from the foothills of the Appalachians to the seas of southern Florida.

Kylie Smith has made the trek many times and knows the way all too well. She has been donning scuba equipment and plunging




into the saltwater of the Florida Keys for the past six years as she completed her master's degree and is now finishing the research for her Ph.D. She has spent hundreds of hours studying the exotic creatures that inhabit coral reefs, measuring fish abundance, testing water quality and acidification levels, and also transplanting fragments of coral and recording their rates of survival and growth. Her experiences have changed her — as a scientist and as a person.

Coral reefs represent some of our oldest and most diverse ecosystems. They cleanse the oceans and provide habitat and food to more than one million species. They even help protect shorelines from erosion by lessening wave height and force. But this invaluable natural resource has been in precipitous decline for the past 30 years. Marine biologists consider



Over 25% of all marine life
depend on coral reefs



In the past 30 years we have
lost 50% of the world's corals

CHASING CORAL

**93% OF HEAT IN THE
EARTH'S ATMOSPHERE IS
ABSORBED BY THE OCEAN**

Without our oceans the average air
temperature would be 122° F.



Join in at:
www.chasingcoral.com

BIOL 4480 Marine Ecology

- explore relationships of marine animals
- understand organismal form, function, ecology
- engage in discussions about the impact of humans
- explore the multi-dimensional challenges
- synthesize alternative solutions to the challenges
- effectively communicate the complex conservation strategies

BIOL 4480 / BIOL 6480

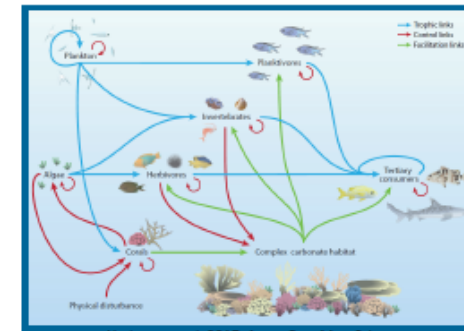
Michael Childress
105 Jordan Hall
mchildr@clemson.edu

Marine Ecology

Meeting time: M, W, F 9:05 - 9:55 am

Meeting place: G33 Jordan Hall

Office hours: T, W 11:00 - 12:30 pm



Harborne et al. 2017. Annu. Rev. Mar. Sci.

Course Description

Marine ecology is the study of the relationships between marine organisms and their ocean environment. Although the ecological processes that govern the transfer of nutrients and energy are similar to those in terrestrial ecosystems, the ocean environment presents many unique challenges for marine communities and the organisms that live there. Students in Marine Ecology will (1) explore the relationships of marine animals to the marine environment, (2) understand the relationships of organismal form, function, ecology, and evolution, and (3) engage in discussions about the impact of humans and climate change on the sustainability of the planet. Marine ecology is also a course in critical thinking where we will examine the complex challenges of marine conservation and human impacts on both local and global scales. In this course you will (4) explore the multi-dimensional challenges of the physical, chemical and biological processes that influence the structure of marine communities, (5) synthesize alternative solutions to the greatest challenges our oceans face today including overharvesting, habitat destruction, and global climate change, and (6) effectively communicate the complex conservation strategies essential for the preservation of our oceans.

Student Learning Objectives

1. Demonstrate the ability to increase critical thinking skills (Application)
2. Identify the limitations of one's own hypotheses, interpretations, or positions. (Analysis)
3. Integrate information/data to solve a problem. (Synthesis)
4. Distinguish and summarize the problem/question at issue (and the source's position). (Analysis)
5. Criticize the appropriateness of procedures for investigating a question of causation. (Evaluation)
6. Interpret quantitative relationships in graphs, tables, charts, etc. (Application)
7. Validate evidence and identify both reasonable and inappropriate conclusions. (Evaluation)
8. Evaluate hypotheses for consistency with established facts. (Evaluation)
9. Assess data for consistency with established facts, hypotheses, or methods. (Evaluation)
10. Prioritize alternative solutions and implement the optimal one(s). (Evaluation)
11. Develop and justify one's own hypotheses, interpretations, or positions. (Synthesis)



Inside this syllabus

Course expectations	2
Grading policy	2
Critical thinking rubric	3
Course schedule	4
About the instructor	5
University policies	5
Honors/grad assignments	6

Special points of interest

- Ecology is the study of the interaction between the environment and the organisms that live there.
- Critical thinking is a systematic and analytical approach to the evaluation of data, ideas, and concepts.
- Marine science is the study of the physical, chemical, and biological processes of ocean

Student Learning Outcomes

1. Demonstrate the ability to increase critical thinking skills (Application)
2. Identify the limitations of one's own hypotheses, interpretations, or positions. (Analysis)
3. Integrate information/data to solve a problem. (Synthesis)
5. Criticize the appropriateness of procedures for investigating a question of causation. (Evaluation)
7. Validate evidence and identify both reasonable and inappropriate conclusions. (Evaluation)
11. Develop and justify one's own hypotheses, interpretations, or positions. (Synthesis)

Incorporating Critical Thinking Activities

- Each week focused on a different student learning outcome (SLO)
- Critical thinking activity (CTA) chosen to match SLO with the lecture topic
- Evaluation of the CTA was rubric based – 20 point maximum
 - Level 1 – Weak – 0-14 points
 - Level 2 – Unacceptable – 15-17 points
 - Level 3 – Acceptable – 18-19 points
 - Level 4 – Strong – 20 points

Strong 4 -- Consistently does all or almost all of the following:

- ✚ Accurately interprets evidence, statements, graphics, questions, etc.
- ✚ Identifies the most important arguments (reasons and claims) pro and con.
- ✚ Thoughtfully analyzes and evaluates major alternative points of view.
- ✚ Draws warranted, judicious, non-fallacious conclusions.
- ✚ Justifies key results and procedures, explains assumptions and reasons.
- ✚ Fair-mindedly follows where evidence and reasons lead.

Acceptable 3 -- Does most or many of the following:

- ✚ Accurately interprets evidence, statements, graphics, questions, etc.
- ✚ Identifies relevant arguments (reasons and claims) pro and con.
- ✚ Offers analyses and evaluations of obvious alternative points of view.
- ✚ Draws warranted, non-fallacious conclusions.
- ✚ Justifies some results or procedures, explains reasons.
- ✚ Fair-mindedly follows where evidence and reasons lead.

Unacceptable 2 -- Does most or many of the following:

- ✚ Misinterprets evidence, statements, graphics, questions, etc.
- ✚ Fails to identify strong, relevant counter-arguments.
- ✚ Ignores or superficially evaluates obvious alternative points of view.
- ✚ Draws unwarranted or fallacious conclusions.
- ✚ Justifies few results or procedures, seldom explains reasons.
- ✚ Regardless of the evidence or reasons, maintains or defends views based on self-interest or preconceptions.

Weak 1 -- Consistently does all or almost all of the following:

- ✚ Offers biased interpretations of evidence, statements, graphics, questions, information or the points of view of others.
- ✚ Fails to identify or hastily dismisses strong, relevant counter-arguments.
- ✚ Ignores or superficially evaluates obvious alternative points of view.
- ✚ Argues using fallacious or irrelevant reasons, and unwarranted claims.
- ✚ Does not justify results or procedures, nor explain reasons.
- ✚ Regardless of the evidence or reasons, maintains or defends views based on self-interest or preconceptions.
- ✚ Exhibits close-mindedness or hostility to reason.

Student Learning Outcomes

SLO Type

- Application

- Analysis

Class Activity

- CCTST pre / post examination
- Multiply hypothesis testing (Excel)

- Random draw debate (articles)
- Group discussion

Application & Analysis

Observation	Date	Location	Transect #	Dict	Turf	Hali	Anmp	Ppac	Wpen	Ecar
1	Jul-17	Elbow	1	3	9	0	1	0	0	1
2	Jul-17	Elbow	2	0	22	3	0	0	0	0
3	Jul-17	Elbow	3	7	8	0	0	0	0	0
4	Jul-17	Elbow	4	5	28	1	0	0	0	0
5	Jul-17	E Turtle	1	0	16	0	0	0	0	1
6	Jul-17	E Turtle	2	1	12	0	0	0	0	0
7	Jul-17	E Turtle	3	0	10	1	0	0	8	0
8	Jul-17	E Turtle	4	0	18	2	0	0	0	0
9	Jul-17	Stag party	1	4	11	7	0	0	0	0
10	Jul-17	Stag party	2	1	11	14	0	0	0	0
11	Jul-17	Stag party	3	6	4	9	0	0	1	0
12	Jul-17	Stag party	4	0	7	8	0	0	0	0
13	Oct-17	Elbow	1	0	4	0	0	1	0	0
14	Oct-17	Elbow	2	0	9	1	0	7	0	0
15	Oct-17	Elbow	3	0	2	0	0	4	0	0
16	Oct-17	Elbow	4	0	14	5	0	4	0	2
17	Oct-17	E Turtle	1	1	7	0	0	2	0	0
18	Oct-17	E Turtle	2	0	0	0	0	1	0	0
19	Oct-17	E Turtle	3	0	1	0	0	1	1	0
20	Oct-17	E Turtle	4	0	11	0	0	2	1	0
21	Oct-17	Stag party	1	0	1	3	0	0	1	0
22	Oct-17	Stag party	2	0	1	11	0	0	5	0
23	Oct-17	Stag party	3	0	1	3	0	1	3	0
24	Oct-17	Stag party	4	1	4	7	0	2	1	0

OIKOS 84: 239–245. Copenhagen 1999

Experimental evidence for the origin of alternative communities on rocky intertidal shores

Peter S. Petraitis and Steven R. Dudgeon

Ecology, 83(12), 2002, pp. 3434–3448
© 2002 by the Ecological Society of America

DO ALTERNATE STABLE COMMUNITY STATES EXIST IN THE GULF OF MAINE ROCKY INTERTIDAL ZONE?

MARK D. BERTNESS,¹ GEOFFREY C. TRUSSELL,² PATRICK J. EWANCHUK, AND BRIAN R. SILLIMAN

Department of Ecology and Evolutionary Biology, Box G-W, Brown University, Providence, Rhode Island 02912 USA

Ecology, 85(4), 2004, pp. 1160–1165
© 2004 by the Ecological Society of America

DO ALTERNATE STABLE COMMUNITY STATES EXIST IN THE GULF OF MAINE ROCKY INTERTIDAL ZONE? COMMENT

Peter S. Petraitis^{1,3} and Steve R. Dudgeon²

Ecology, 85(4), 2004, pp. 1165–1167
© 2004 by the Ecological Society of America

DO ALTERNATE STABLE COMMUNITY STATES EXIST IN THE GULF OF MAINE ROCKY INTERTIDAL ZONE? REPLY

Mark D. Bertness,^{1,2} Geoffrey C. Trussell,²
Patrick J. Ewanchuk,² and Brian R. Silliman¹

Student Learning Outcomes

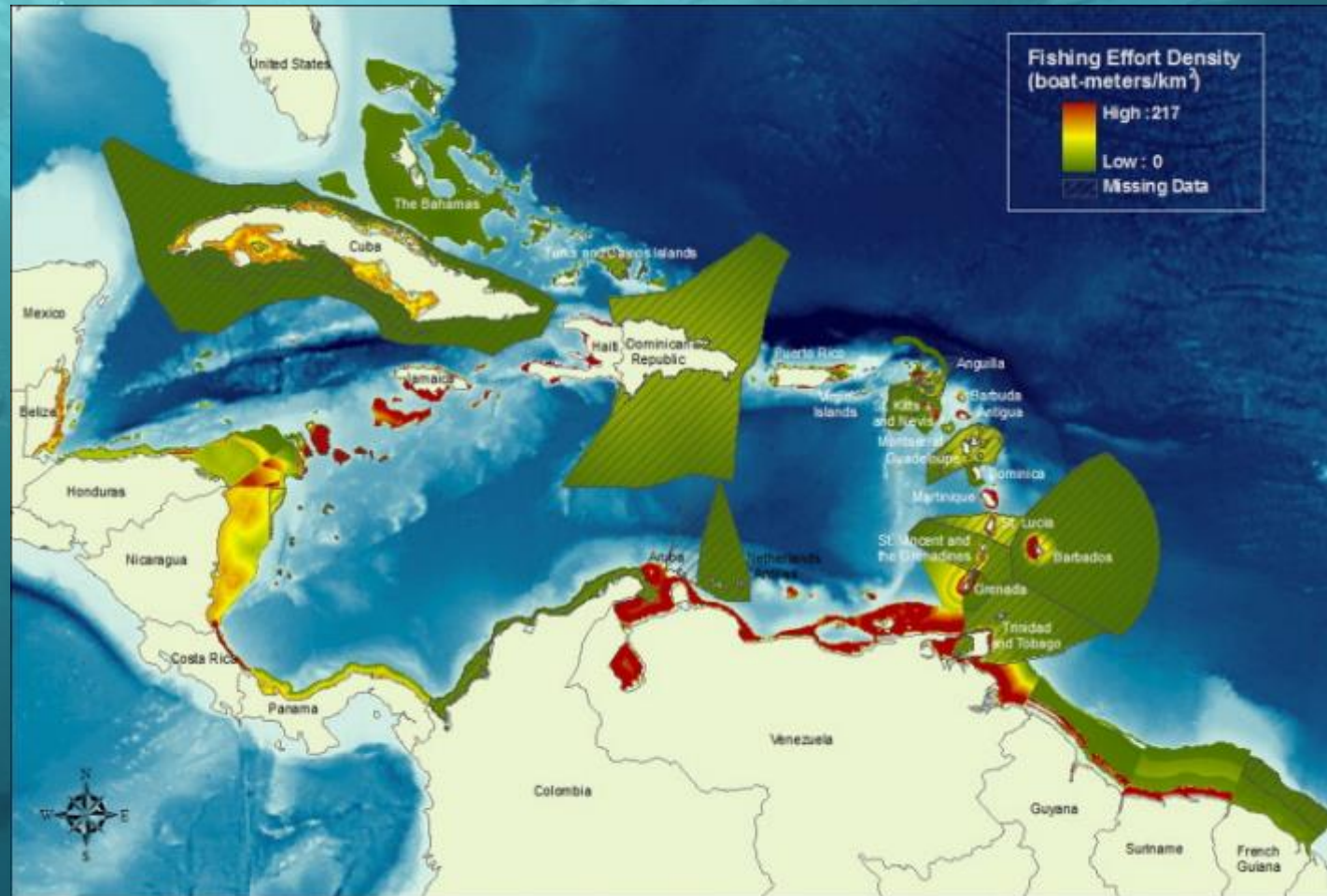
SLO Type

- Evaluation
- Synthesis

Class Activity

- Critical movie review (Chasing Coral)
- Us vs. them debate (climate change)
- Persuasive essay
- Calculation and analysis (Excel)
- Marine spatial management plan

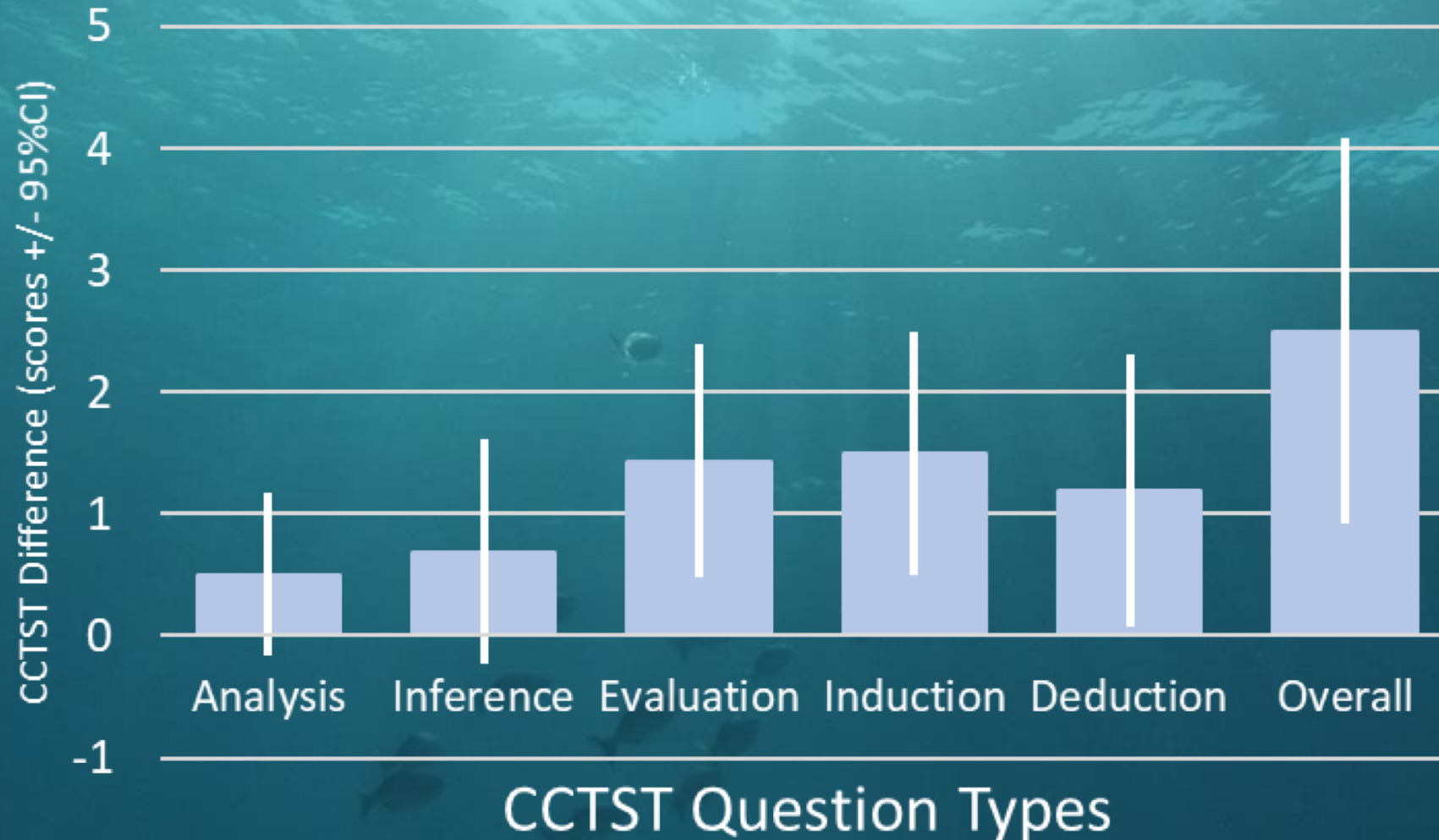
Evaluation & Synthesis



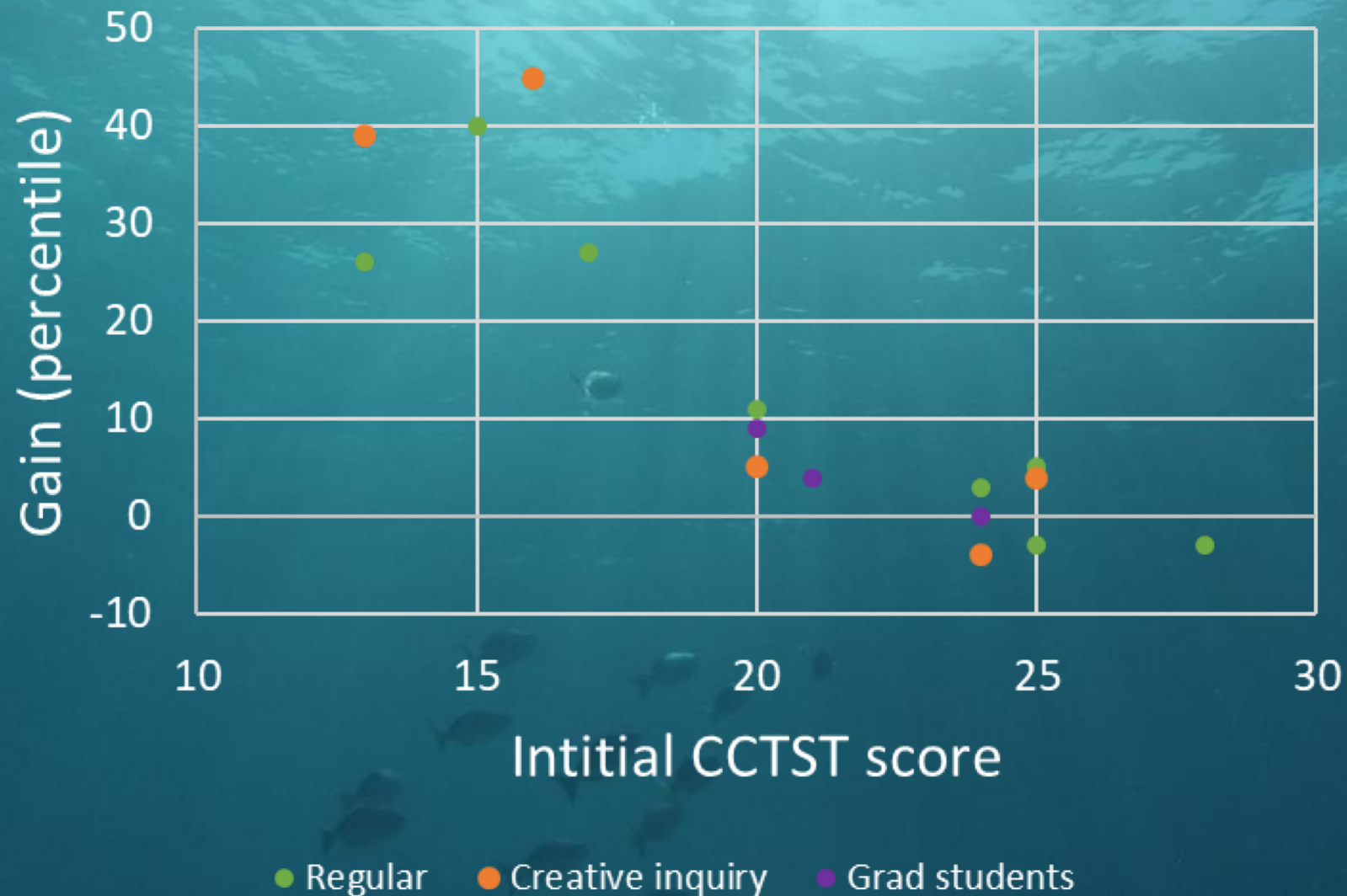
Course Self Assessment

- explore relationships of marine animals
 - understand organismal form, function, ecology
 - engage in discussions about the impact of humans
 - explore the multi-dimensional challenges
 - synthesize alternative solutions to the challenges
 - effectively communicate the complex conservation strategies
- Good – 2
 - Very good – 3
 - Excellent – 4
 - Very good – 3
 - Good – 2
 - Very good - 3

California Critical Thinking Skills Test



California Critical Thinking Skills Test



Student Evaluations - Strengths

- I liked having the critical thinking activities. They helped me grow and better understand the material.
- I really enjoyed the critical thinking exercises and class discussions. They brought up issues that are both culturally important and complicated. I felt discussions focused on the most important current issues facing marine ecology and conservation.
- Notes and scientific paper reading were very helpful, as were other activities we conducted in class. Though I understand its purpose, the Critical Thinking Skills test was a little frustrating, specifically because this is the fourth time I have taken it and I seem to receive approximately the same score every time. Perhaps considering another method of analyzing critical thinking skills could be helpful.

Final Thoughts





This invaluable natural resource has been in precipitous decline for the past 25 years. Marine biologists consider these reefs to be the most critically imperiled ecosystem on the planet.

