Marine Megafauna Ecology
SFS 3722

Syllabus
4 credits

The School for Field Studies (SFS) & Blue World Institute (BWI)
Center for the Conservation of Marine Megafauna
Veli Lošinj, Lošinj Island, Croatia

This syllabus may develop or change over time based on local conditions, learning opportunities, and faculty expertise. Course content may vary from semester to semester.

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COURSE CONTENT SUBJECT TO CHANGE

Please note that this is a copy of a recent syllabus. A final syllabus will be provided to students on the first day of academic programming.

SFS programs are different from other travel or study abroad programs. Each iteration of a program is unique and often cannot be implemented exactly as planned for a variety of reasons. There are factors which, although monitored closely, are beyond our control. For example:

- Changes in access to or expiration or change in terms of permits to the highly regulated and sensitive environments in which we work;
- Changes in social/political conditions or tenuous weather situations/natural disasters may require changes to sites or plans, often with little notice;
- Some aspects of programs depend on the current faculty team as well as the goodwill and generosity of individuals, communities, and institutions which lend support.

Please be advised that these or other variables may require changes before or during the program. Part of the SFS experience is adapting to changing conditions and overcoming the obstacles that may present. In other words, the elephants are not always where we want them to be, so be flexible!

Course Overview

The goal of this course is to provide students with in-depth theoretical knowledge and practical, applicative skills in research and conservation management of marine megafauna.

Marine megafauna, such as marine mammals, sea turtles, elasmobranchs and other large predatory fishes share a similar life history characterized by long life span, late maturation, and low reproduction. Such evolutionary traits make them particularly sensitive to perturbations in population's vital rates due to increased human-induced mortality, which caused severe decline across different species and populations over the last century. As keystone species, these animals occupy high trophic levels in marine food webs and are crucial for shaping structure, diversity, and dynamics of marine ecosystems through top-down processes.

Even though these animals are difficult to study, the knowledge on most species has increased significantly in the last two decades thanks to employment of new research methods and technologies. This course will provide in-depth knowledge on the biology of marine megafauna and their ecological roles in marine ecosystems, with emphasis on cetaceans and sea turtles. Special attention will be given to diversity, functional physiology and adaptations, ecology, synergistic impacts of human-caused threats, and contemporary conservation approaches, with emphasis on Mediterranean species. Moreover, the course will practically introduce students to state-of-the-art techniques and quantitative methods for research and conservation of marine megafauna, specifically cetaceans and sea turtles. Students taking this course will be able to focus on particular subjects and/or taxonomic groups, depending on their scientific interests.

Learning Objectives

After taking this course, students will:

1. Knowledge and understanding:
    a. Understand evolutionary history, systematic and diversity of marine megafauna, specifically sea turtles and cetaceans.
    b. Adopt knowledge on biology, adaptations, and ecology of sea turtles and cetaceans.
    c. Understand status, threats and ecosystem-based conservation approaches related to sea turtles and cetaceans.
    d. Be able to independently plan and perform research on sea turtles and cetaceans by applying state of the art methodologies and techniques.

2. Reflection:
    a. With completion of this course students will be able to develop research projects and evidence-based conservation strategies.
    b. Prioritize conservation decision making for marine megafauna, adopting the ecosystem-based approach.

3. Application:
    a. Selection and application of the appropriate state-of-the-art methodologies for studying ecology and habitat use of marine megafauna, specifically sea turtles and cetaceans.
    b. Identification and quantification of anthropogenic threats to sea turtles and cetaceans.
    c. Development and implication of ecosystem-based conservation management plans for sea turtles and cetaceans.

Assessment

The evaluation breakdown for the course is as follows:

Assessment Item	Value (%)
Participation	10
Quiz 1	10
Quiz 2	10
Field Exercise: Satellite Tracking	20
Field Exercise: Photo Identification	30
Final Exam	20
TOTAL	**100**

Participation (10%)

Everybody should be prepared for each academic session. This implies reading the materials for each session with enough detail to be able to ask relevant questions; and to participate in analytical discussions about the key issues. Active participation during lectures, discussions, field lectures and lab exercises is expected.

Quiz 1 (10%)

This quiz will comprise essay and multiple-choice questions, covering topics from general introduction to marine megafauna, over sea turtles to conservation of sea turtles (items 1 to 12 in the Course Content table below).

Quiz 2 (10%)

This quiz will test how well students have adopted general knowledge on cetaceans (items 13 to 15, 19 and 20 in the Course Content table below). The quiz will consist of an essay and multiple-choice questions.

Field Exercise: Satellite Tracking (20%)

Students will be assessed based on the reports which are submitted. The reports should show the ability to define a research goal, plan a survey, collect data, perform analyses, and present results. For this, students will be guided through introductory lessons and field lectures (Items 8 and 9 in the Course Content table below) during boat- and lab-based surveys during which they will gather and analyze satellite tracking data of sea turtles.

Field Exercise: Photo Identification (30%)

Students will be assessed based on the reports which are submitted. The reports should show the ability to define a research goal, plan a survey, collect data, perform analyses, and present results. For this, students will be guided through introductory lessons and field lectures (Items 16 and 17 in the Course Content table below) during boat-based surveys during which they will collect photo-identification data which they will have to independently analyze and use to base their report upon.

Final Exam (20%)

A final exam will be given based on material covered in lectures, readings, and field experiences. It will consist of 3 sections, including multiple choice questions as well as short essay questions. There will be an exam review session before the exam.

Grading Scheme

A	95.00 - 100.00%	B+	86.00 - 89.99%	C+	76.00 - 79.99%	D	60.00 - 69.99%
A-	90.00 - 94.99%	B	83.00 - 85.99%	C	73.00 - 75.99%	F	0.00 - 59.99%
		B-	80.00 - 82.99%	C-	70.00 - 72.99%		

General Reminders

Honor Code/Plagiarism – SFS places high expectations on their students and we hold students accountable for their behaviors. SFS students are held to the honor code below. SFS has a zero-tolerance policy towards student cheating, plagiarism, data falsification, and any other form of dishonest academic and/or research practice or behavior. Using the ideas or material of others without giving due credit is cheating and will not be tolerated. Any SFS student found to have engaged in or facilitated academic and/or research dishonesty will receive no credit (0%) for that activity.

> *"SFS does not tolerate cheating or plagiarism in any form. While participating in an SFS program, students are expected to refrain from cheating, plagiarism and any other behavior which would result in a student receiving credit for work which they did not accomplish on their own. Students are expected to report any instance of cheating or plagiarism by others."*

Deadlines – Deadlines for written and oral assignments are instated to promote equity among students and to allow faculty ample time to review and return assignments before others are due. As such, deadlines are firm; extensions will only be considered under extreme circumstances. Late assignments will incur a penalty of 10% of your grade for each day you are late. After two days past the deadline, assignments will no longer be accepted. Assignments will be handed back to students after a one-week grading period. Grade corrections for any assessment item should be requested in writing at least 24 hours after assignments are returned. No corrections will be considered afterwards.

Content Statement – Every student comes to SFS with unique life experiences, which contribute to the way various information is processed. Some of the content in this course may be intellectually or emotionally challenging but has been intentionally selected to achieve certain learning goals and/or showcase the complexity of many modern issues. If you anticipate a challenge engaging with a certain topic or find that you are struggling with certain discussions, we encourage you to talk about it with faculty, friends, family, the HWM, or access available mental health resources.

Participation – Since we offer a program that is likely more intensive than you might be used to at your home institution, missing even one lecture can have a proportionally greater effect on your final grade simply because there is little room to make up for lost time. Participation in all components of the course is mandatory, it is important that you are prompt for all activities, bring the necessary equipment for field exercises and class activities, and simply get involved.

Course Content

Type: D: Discussion, **FL:** Field Lecture, **GL:** Guest Lecture, **L**: Lecture, **O**: Orientation, **LAB**: Lab exercise

No	*Title and outline*	*Type*	*Time (hrs)*	*Required Readings*
1	**Course Introduction** What is "large" in the ocean?	O	1.0	Moleón, et al. (2020)
2	**Adaptations and Physiological Ecology of Marine Megafauna**	L	2.0	Costa (2007).
3	**Evolutionary Background** Evolutionary strategies and life histories of large marine vertebrates	L	2.0	Agnew (2000).
4	**Spatial Ecology** Movements of large marine vertebrates: theoretical backgrounds and study methods	L	2.0	Kot, et al. (2022). Grémillet, et al. (2022).
Sea Turtles				
5	**Introduction to Biology of Sea Turtles** Evolution, systematics, life history types, thermobiology	L	1.0	Fraizer (2001). Bolten (2003).
6	**Introduction to Reproductive Biology of Sea Turtles**	L	1.0	Miller, et al. (2003). Fuentes, et al. (2024).
7	**In-water Biology of Sea Turtles**	L	1.0	Jones & Seminoff (2013). Casale, et al. (2018).
8	**Field Exercise 1, part 1** Satellite tracking of sea turtles	FL	2.0	
9	**Field Exercise 1, part 2** Satellite tracking data analysis	LAB	2.0	
10	**Lab Exercise** Sampling methods and analysis in feeding ecology studies of sea turtles	LAB	2.0	Forbes (1999).
11	**Conservation Status of Sea Turtle Populations**	D	2.0	Wallace, et al. (2010). Mazaris, et al. (2017).
12	**What shapes difference in conservation status of sea turtles?**	D	1.0	Wallace, et al. (2011).
Cetaceans				
13	**Introduction to Biology of Cetaceans** Evolution, systematics, diversity, and biogeography	L	1.0	Berta, et al. (2015a,b).
14	**Introduction to Biology of Cetaceans** Ecology, reproductive biology, and communication of cetaceans	L	1.0	Berta, et al. (2015c,d).
15	**Population Structure and Dynamics of Cetaceans**	L	1.0	Berta, et al. (2015e). Pleslić, et al. (2019).

No	Title and outline	Type	Time (hrs)	Required Readings
16	**Field Exercise 2, part 1** Photoidentification of cetaceans using naturally occurring features	FL	2.0	Urian, et al. (2015).
17	**Field Exercise 2, part 2** Photoidentification of bottlenose dolphins using the BWI catalogue	LAB	2.0	Pleslić, et al. (2015).
18	**Lab Exercise** Sampling methods and analysis in feeding ecology studies of cetaceans	LAB	2.0	
19	**Conservation Status of Cetacean Populations**	D	2.0	ACCOBAMS 2021
Population Ecology				
20	**Ecological Role of Megafauna in Marine Ecosystems**	D	1.0	Pimiento, et al. (2020). Heithaus (2013).
21	**Abundance Estimate Methods for Marine Megafauna** Capture-Mark-Recapture methods and distance sampling	L	2.0	Buckland, et al. (2015).
22	**Lab Exercise** Capture-Mark-Recapture methods	LAB	2.0	
23	**Lab Exercise** Quantification of population trend	L	2.0	Mills (2013a,b).
24	**Lab Exercise** Quantification of exponential population trend	LAB	2.0	
25	**Population-projection Models** Introduction and application of population models to conservation management of marine megafauna	L	4.0	Heppell, et al. (2000a). Heppell, et al. (2000b).
26	**Lab Exercise** Building population matrix models	LAB	2.0	Heppell, et al. (2003a).
27	**Lab Exercise** Sea turtle population models	LAB	2.0	Heppell, et al. (2003b).
28	**Age-structured Populations and Vital Rates**	L	2.0	Mills (2013c)
29	**Lab Exercise** Population vital rates: survival, reproduction, and growth models	LAB	2.0	
	Total		**51**	
	UMN Instructional Hours		**61.2**	

**UMN defines an instructional hour as a 50-minute block. SFS syllabi are written in full 60-minute hours for programming purposes. Therefore 50 full hours = 60 UMN instructional hours (for four credit courses) and 25 full hours = 30 UMN instructional hours (for two credit courses).*

Reading List

1. ACCOBAMS, 2021. Conserving Whales, Dolphins and Porpoises in the Mediterranean Sea, Black Sea and adjacent areas: an ACCOBAMS status report, (2021). By: Notarbartolo di Sciara G., Tonay A.M. Ed. ACCOBAMS, Monaco. 160 p.

2. Agnew, D. (2000). Life in the slow lane: Ecology and conservation of long-lived marine animals. Fisheries Management & Ecology. 7.

3. Berta A., Sumich J. & Kovacs K. (2015a). Chapter 4. Cetacean Evolution and Systematics. In: Marine mammals: Evolutionary biology. Third edition. Elsevier Academic Press, London.

4. Berta A., Sumich J. & Kovacs K. (2015b). Chapter 6. Evolution and Geography. In: Marine mammals: Evolutionary biology. Third edition. Elsevier Academic Press, London.

5. Berta A., Sumich J. & Kovacs K. (2015c). Chapter 11. Sound Production for Communication, Echolocation, and Prey Capture. In: Marine mammals: Evolutionary biology. Third edition. Elsevier Academic Press, London.

6. Berta A., Sumich J. & Kovacs K. (2015d). Chapter 13. Reproductive Structures, Strategies, and Patterns. In: Marine mammals: Evolutionary biology. Third edition. Elsevier Academic Press, London.

7. Berta A., Sumich J. & Kovacs K. (2015e). Chapter 14. Population Structure and Dynamics. In: Marine mammals: Evolutionary biology. Third edition. Elsevier Academic Press, London.

8. Bolten, A.B. (2003). Variation in sea turtle life history patterns: neritic vs. oceanic developmental stages. In: Lutz, P.L., Musick, J.A., Wyneken, J. (Ed) The biology of sea turtles, Vol. 2. CRC Press, Boca Raton: 243-257.

9. Buckland, S. T., Rexstad, E. A., Marques, T. A., & Oedekoven, C. S. (2015). Distance sampling: methods and applications (Vol. 431). New York: Springer.

10. Casale, P., Broderick, A.C., Camiñas, J.A., Cardona, L., Carreras, C., Demetropoulos, A., Fuller, W.J., Godley, B.J., Hochscheid, S., Kaska, Y., Lazar, B. (2018). Mediterranean sea turtles: Current knowledge and priorities for conservation and research. Endangered Species Research 36: 229-267. DOI: 10.3354/esr00901

11. Costa, D. (2007). Diving Physiology of Marine Vertebrates. 10.1002/9780470015902.a0004230.

12. Forbes, G. (1999). Diet sampling and diet component analysis. In: Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A., Donelly, M. (Ed) Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group 4: 144–155.

13. Fraizer, J.G. (2001). General natural history of marine turtles. In: Eckert, K.L., Abreu Grobois, F.A. (Ed). Proceedings, Marine Turtle Conservation in the Wider Caribbean Region —A Dialogue for Effective Reginal Management. WIDECAST, IUCN/SSC/MTSG, WWF, and the UNEP Caribbean Environment Programme: 3-17.

14. Fuentes, M. M. P. B. , Santos, A. J. B. , Abreu-Grobois, A. , Briseño-Dueñas, R. , Al-Khayat, J. , Hamza, S., Saliba, S. , Anderson, D. , Rusenko, K. W. , Mitchell, N. J. , Gammon, M. , Bentley, B. P. , Beton, D., Booth, D. T. B. , Broderick, A. C. , Colman, L. P. , Snape, R. T. E. , Calderon-Campuzano, M. F. , Cuevas, E. … Monsinjon, J. R. (2024). Adaptation of sea turtles to climate warming: Will phenological responses be

sufficient to counteract changes in reproductive output? Global Change Biology, 30, e16991. https://doi.org/10.1111/gcb.16991

15. Grémillet, D., Chevallier, D., Guinet, C. (2022). Big data approaches to the spatial ecology and conservation of marine megafauna, ICES Journal of Marine Science, 79(4), 975–986. https://doi.org/10.1093/icesjms/fsac059

16. Heithaus, M.R. (2013). Predators, prey, and the ecological roles of sea turtles. In: Wyneken, J., Lohmann, K.J., Musick, J.A. (Ed) The Biology of Sea Turtles, Volume III. CRC Press, Boca Raton.

17. Heppell, S.S., Caswell, H., Crowder, L.B. (2000b). Life histories and elasticity patterns: Perturbation analysis for species with minimal demographic data. Ecology 81(3): 654-665.

18. Heppell, S.S., Crouse, D.T., Crowder, L.B. (2000a). Using matrix models to focus research and management efforts in conservation. In: Ferson, S., Burgman, M. (Ed) Quantitative Methods for Conservation Biology. Springer-Verlag, NY.: 148-168.

19. Heppell, S.S., Crowder, L.B., Crouse, D.T., Epperly, S.P., Frazer, N.B. (2003b). Population models for Atlantic loggerheads: past, present and future. In: Bolten, A.B., Witherington, B.E. (Ed) Loggerhead sea turtles. Smithsonian Institution Press, Washington, DC: 255-273.

20. Heppell, S.S., Snover, M.L., Crowder, L.B. (2003a). Sea turtle population ecology. In: Lutz, P.L., Musick, J.A., Wyneken, J. (Ed) The biology of sea turtles Vol. 2 CRC Press, Boca Raton: 275-306.

21. Jones, T.T., Seminoff, J.A. (2013). Feeding biology: Advances from field-based observations, physiological studies, and molecular techniques. In: Wyneken, J., Lohmann, K.J., Musick, J.A. (Ed) The Biology of Sea Turtles, Volume III. CRC Press, Boca Raton.

22. Kot, C. Y., Åkesson, S., Alfaro-Shigueto, J., Llanos, D. F. A., Antonopoulou, M., Balazs, G. H., et al. (2022). Network analysis of sea turtle movements and connectivity: A tool for conservation prioritization. Diversity and Distributions, 28(4), 810–829. https://www.jstor.org/stable/48654009

23. Mazaris, A.D. et al. (2017). Global sea turtle conservation successes. Science Advances 3, e1600730.DOI:10.1126/sciadv.1600730

24. Miller, J.D., Limpus, C.J., Godfrey, M.H. (2003). Nest site selection, oviposition, eggs, development, hatching, and emergence of loggerhead turtles. In: Bolten, A.B., Witherington, B.E. (Ed) Loggerhead Sea Turtles, Washington, Smithsonian Books: 125-143.

25. Mills, L. S. (2013a). Chapter 5. The simplest way to describe and project population growth: exponential or geometric change. In: Conservation of Wildlife Populations: Demography, genetics, and management, Second edition. John Wiley & Sons.

26. Mills, L. S. (2013b). Chapter 7. Density dependent population change. In: Conservation of Wildlife Populations: Demography, genetics, and management, Second edition. John Wiley & Sons.

27. Mills, L. S. (2013c). Chapter 4. Estimating population vital rates. In: Conservation of Wildlife Populations: Demography, genetics, and management, Second edition. John Wiley & Sons.

28. Moleón, M., Sánchez-Zapata, J.A., Donázar, J.A., Revilla, E., Martín-López, B., Gutiérrez-Cánovas, C. et al. (2020). Rethinking megafauna. Proc. R. Soc. B.2872019264320192643. http://doi.org/10.1098/rspb.2019.2643

29. Pimiento, C., Leprieur, F., Silvestro, D., Lefcheck, J.S., Albouy, C., Rasher, D.B., Davis, M., Svenning, J.C., Griffin, J.N. (2020). Functional diversity of marine megafauna in the Anthropocene. Science Advances 6(16), 1-12. DOI:10.1126/sciadv.aay7650

30. Pleslić G, Rako Gospić N, Mackelworth P, Wiemann A, Holcer D, Fortuna C (2015) The abundance of common bottlenose dolphins (Tursiops truncatus) in the former special marine reserve of the Cres-Lošinj Archipelago, Croatia. Aquatic Conservation: Marine and Freshwater Ecosystems 25 (1): 125-137

31. Pleslić, G., Rako-Gospić, N., Miočić-Stošić, J., Blazinić Vučur, T., Radulović, M., Mackelworth, P., ... and Holcer, D. (2019). Social structure and spatial distribution of bottlenose dolphins (Tursiops truncatus) along the Croatian Adriatic coast. Aquatic Conservation: Marine and Freshwater Ecosystems, 29(12), 2116-2132.

32. Urian K, Gorgone A, Read A, Balmer B, Wells RS, Berggren P, Durban J, Eguchi T, Rayment W, Hammond PS (2015) Recommendations for photo-identification methods used in capture-recapture models with cetaceans. Marine Mammal Science 31 (1): 298-321.

33. Wallace B.P., DiMatteo A.D., Hurley BJ, Finkbeiner E.M., Bolten A.B., Chaloupka M.Y., et al. (2010) Regional Management Units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLoS ONE 5(12): e15465. https://doi.org/10.1371/journal.pone.0015465

34. Wallace, B.P., DiMatteo, A.D., Bolten, A.B., Chaloupka, M.Y., Hutchinson, B., et al. (2011). Global conservation priorities for marine turtles. PloS One. 6. e24510. DOI: 10.1371/journal.pone.0024510.