**BIOL6421 COASTAL HABITAT RESTORATION AND REHABILITATION**

(3 Credits) (Semester 3/Summer Term with final exam in Semester 1)

**Aims and Distinctive Features:**

Healthy coastal ecosystems offer protection against the ravages of natural disasters and climate induced changes like excessive land runoff and increased storminess. Coastal systems have come under increasing threat from human activities and natural disasters. The rate of loss of these systems and associated habitats has accelerated in recent decades due to chronic levels of impacts and climate variability. This loss must be mitigated in light of the tremendous ecosystem services provided by these ecosystems and the need for resilience in the face of a changing climate. It is therefore necessary to assist the natural systems to recover from human/climate induced degradation so that the ecosystem services and associated benefits can be perpetuated or even improved.

This course will expose students to the causes of coastal habitat degradation and loss, the loss in associated ecosystem services and therefore the need for effective options and approaches to generate real habitat rehabilitation or restoration. It will assist students to conduct field and desk-top assessments to diagnose these impacts and design effective interventions. Environmental professionals and practitioners who seek to design effective rehabilitation plans for coastal habitats to mitigate loss will learn what works through actual hands-on rehabilitation exercises. Furthermore, there has been ongoing research and continued development of alternative restoration techniques, applicable to small island developing states like Jamaica.

**Learning Outcomes:**

On successful completion of the course, students should be able to:

1. Differentiate between coastal habitat rehabilitation and restoration
2. Identify and evaluate ecosystem services and associated value of the individual and interacting habitats.
3. Understand the desirability of conservation as an alternative to restoration.

4. For corals/coral reefs:
    a. Identify and diagnose reasons for habitat loss in coral reef ecosystems
    b. Triage potential donor and recipient sites, assessing suitability for either purpose
    c. Establish the objective of the restoration activity (structural integrity vs topographic complexity vs. species diversity and abundance levels )
    d. Evaluate and propose appropriate restoration/replantation techniques (incl. coral gardening and u/w or *ex-situ* nurseries, transplanting techniques) for local (Jamaican/Caribbean) applications
    e. Design appropriate restoration/rehabilitation techniques and monitor to establish success / failure of the activity

2. For mangroves:
    a. Demonstrate an understanding of the various biological and physical parameters that affect mangrove forest loss and decline.
    b. Apply the different tools, equipment and techniques used to collect associated biological and physical **data to diagnose** coastal forest changes, anomalies, loss and degradation.
    c. Analyse ecological mangrove restoration and adaptive management approaches by reviewing global and regional case studies of mangrove restorations or restoration attempts.
    f. Apply various techniques used **to manipulate** the physical factors that need to be considered to achieve ecological mangrove restoration.
    g. Apply appropriate monitoring protocols to evaluate the r success/failure of mangrove restoration sites

Seagrasses:
    a. Analyse the various methods employed globally in seagrass restoration and their suitability for local (Jamaican/Caribbean) application.
    b. Design and prescribe rehabilitation methods/interventions based on different factors causing loss
    c. Evaluate the factors which will affect success or failure at potential restoration sites
    d. Determine appropriate techniques to establish success/failure of the activity

e. Apply appropriate monitoring protocols to evaluate the success/failure of seagrass restoration sites

**Mode of delivery:**

Face to face at DBML

| Method/Approach | Contact hours | Credit hours |
|---|---|---|
| Formal Lectures: | 18 | 18 |
| Tutorials/Seminars: | 6 | 3 |
| Laboratory and Field work: | 30 | 15 |
| (inclusive of case study presentation and discussion). | | |
| ***Total:*** | ***54*** | 36 |

**Course Content:**

This course will cover the following:

1. Principles and best practices of degraded habitat assessment (reefs, mangroves, seagrasses)
2. Principles of environmental conservation, mitigation , retribution and restoration (including case studies)
3. The causes of habitat degradation and loss (reefs , mangroves, seagrasses)
4. Collecting/measuring and analysing relevant data related to ecosystem health or degradation-including types of tools and equipment used, and their operation.
5. Ecosystem restoration/rehabilitation techniques (natural and artificial reefs, mangroves, seagrasses, e.g. Modifying landscapes, compaction, nursery seedlings vs. wildings, monitoring plots
6. Assessing the success of habitat restoration (reefs , mangroves, seagrasses) efforts (lessons learned)
7. Aesthetic considerations
8. Economic consideration (ecosystem services and their value vs. cost of rehabilitation)
9. Ethical dilemmas in ecological restoration

**Assessment:**

(Students are required to pass both Final Exam and Coursework components)

| | | |
|---|---|---|
| One 2-Hour Written Final Examination Paper | 50% | |
| Course Work | | 50% |
| Oral Presentation (x2) | 20% | |
| Field Report (x2) | 20% | |
| Management Protocol for 1 habitat (x1) | 10% | |

**TEXT-** Ecological Restoration by Susan M. Galatowitsch Oxford University Press. ISBN-13: 978-0878936076 /ISBN-10: 0878936076 (2nd Ed- 2017?).

**HIGHLY RECOMMENDED READING**


**MANGROVES:**

**Ellison AM** (2000) Mangrove Restoration: do we know enough? Restoration Ecology 8: Vol. 3, pp.219-229.

**Lewis RR (**1982).Mangrove forests. Creation and restoration of coastal plant communities. CRC Press, pp 153–173.

**Lewis RR et al** (2016). Stress in mangrove forests: Early detection and pre-emptive rehabilitation are essential for future successful worldwide mangrove forest management." Marine pollution bulletin 109, no. 2 : 764-771, 2016.

**CORAL REEFS:**

**Coral Reef Restoration Handbook** (2006) Ed. William F. Precht eBook ISBN9781420003796

**Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS, Greenfield P, Gomez E, Harvell CD, Sale PF, Edwards AJ, Caldeira K, Knowlton N, Eakin CM, Iglesias-Prieto R, Muthiga N, Bradbury RH, Dubi A, Hatziolos ME. (**2007**).** Ocean Reefs Under Rapid Climate Change and Ocean Acidification. SCIENCE 318, 1737.
**Hughes TP.** (1994). Catastrophes, Phase Shifts and Large Scale Degradation of a Caribbean Coral Reef. SCIENCE: 265. 1547 – 1551.
**Jackson et al**. (2014). Status and Trends of Caribbean Coral Reefs; 1970 – 2012. IUCN

**Hughes TP, Graham NAJ, Jackson JBC, Mumby PJ, Steneck RS** (2010) Rising to the challenge of sustaining coral reef resilience Volume 25, Issue 11, pp 633-642
**Rinkevich B**. (2005). Conservation of Coral Reefs through Active Restoration Measures: Recent Approaches and Last Decade Progress. Environ. Sci. Technol. 39: 4333-4342

***SEAGRASSES:***

***Spalding MD, Ruffo S, Lacambra CL, Meliane I, Zeitlin-Hale L, Shepard CC, Beck MW,*** *(2014) The role of ecosystems in coastal protection: Adapting to climate change and coastal hazards. Ocean & Coastal Management* ***Volume 90, March 2014, Pages 50-57***

**van Tussenbroek, BI et al.** (2010) A guide to the tropical seagrasses of the Western Atlantic. *Universidad Nacional Autonoma de Mexico*

**ADDITIONAL RECOMMENDED READING**

**Andres NG, Witman JD.** (1995). Trends in community structure on a Jamaican Reef. MARINE ECOLOGY PROGRESS SERIES 118: 305 – 310.

**Delgado, P., Hensel , P F, Jiménez, JA, & Day JW.** (2001). The importance of propagule establishment and physical factors in mangrove distributional patterns in a Costa Rican estuary. Aquatic Botany 71, no. 3: 157-178.

**Doyle TW** (2003). Effects of Hydrology on Red Mangrove Recruits. http://www.nwrc.usgs.gov/factshts/029-03.pdf. Accessed August 27, 2006.

**Duke NC** (1992). Mangrove floristics and biogeography, in Tropical Mangrove Ecosystems (eds Robertson, A.I. & Alongi, D.M.). American Geophysical Union, Washington, D.C.. pp. 63–100.

**Forsman Z, Rinkevich B, Hunter C**. (2006). Investigating fragment size for culturing reef-building corals (*Porites lobata* and *P. compressa*) in ex situ nurseries. AQUACULTURE 261:89–97
DOI 10.1016/j.aquaculture.2006.06.040.

**Harrington L, Fabricius K, De'Ath G, Negri A. (**2004). Recognition and selection of settlement substrata determine post-settlement survival in corals. ECOLOGY 85:3428–3437. DOI 10.1890/04-0298.

**Hughes TP, Keller BD, Jackson JCB, Boyle MJ. (**1985). Mass mortality of the echinoid *Diadema antillarum* (Philippi) in Jamaica. BULLETIN OF MARINE SCIENCE 36(2): p 377-384.

**Jorge A. Jimenez, JA, Lugo AE** (2007). "Business and Sound Environmental Management in the Caribbean - What Makes It Work?". JIEP (Jamaica Institute of Environmental Professionals). Third National Conference on the Environment;

**Kojis BL, Quinn NJ.** (2001). The importance of regional differences in hard coral recruitment rates for determining the need for coral restoration. BULLETIN OF MARINE SCIENCES 69:967–974.

**Komyakova V, Munday PL, Jones GP. (**2013). Relative Importance of Coral Cover, Habitat Complexity and Diversity in Determining the Structure of Reef Fish Communities. PLOS ONE: Volume 8; Issue 12, e83178.

**Lough JM, Barnes DJ.** (2000)**.** Environmental controls on growth of the massive coral *Porites*. JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY 245:225–243. DOI 10.1016/S0022-0981(99)00168-9.

**Marion SR, Orth RJ** (2010) Innovative Techniques for Large-scale Seagrass Restoration Using Zostera marina (eelgrass) Seeds. Restoration Ecology Vol. 18, No. 4, pp. 514–526

**Raymundo LJ, Maypa AP.** (2004)**.** Getting bigger faster: mediation of size-specific mortality via fusion in juvenile coral transplants. ECOLOGICAL APPLICATIONS 14:281–295 DOI 10.1890/02-5373.

**Toh TC, Ng CSL, Guest J, Chou LM.** (2013)**.** Grazers improve health of coral juveniles in ex situ mariculture. AQUACULTURE 414:288–293. DOI 10.1016/j.aquaculture.2013.08.025.

***van Katwijk MM, Bos AR, de Jonge VN, Hanssen LSAM, Hermus DCR, de Jong DJ (2009)*** *Guidelines for seagrass restoration: Importance of habitat selection and donor population, spreading of risks, and ecosystem engineering effects. Marine Pollution Bulletin* ***Volume 58, Issue 2, pp 179-188***

**Woodley, JD.** (1980). Hurricane Allen destroys Jamaican coral reefs. NATURE 287:387

**ON-LINE RESOURCES**

[include as necessary; other types of resources may be included with appropriate headings]

**Biello, D.,** (2008) Coral Grief: Warming Climate Threatens Reef Destruction SCIENTIFIC AMERICAN https://www.scientificamerican.com/article/coral-grief-warming-climate-threatens-reef-destruction/

**Forsman ZH, Page CA, Toonen RJ, Vaughan D**. (2015). Growing coral larger and faster: micro-colony-fusion as a strategy for accelerating coral cover. PEERJ 3: e1313 https://doi.org/10.7717/peerj.1313

**Seagrass Restoration** Florida Fish and Wildlife Conservation Commission http://myfwc.com/research/habitat/seagrasses/projects/active/restoration/

**van Katwijk M, Thorhaug A, Marbà N, Orth RJ, Duarte CM, Kendrick GM, Althuizen IHJ, Balestri E** (2015) Global analysis of seagrass restoration: the importance of large-scale planting https://doi.org/10.1111/1365-2664.12562

**Vance E. (2011).** Can Coral Nurseries Bring Reefs Back from the Brink? SCIENTIFIC AMERICAN https://www.scientificamerican.com/article/coral-nurseries-bring-reefs-back-from-brink/