https://doi.org/10.56975/ijcrt.v13i8.292525

IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

"A Study On Ecosystem Services Provided By Sea Weeds: "In The Silent Forests Beneath The Waves, Seaweeds Weave The Fabric Of Ocean Life."

Smt. G.R.N.S. Sujatha, Lecturer in Botany, Dr. V.S Krishna Govt. Degree College(A),Visakhapatnam.

Dr. P. Swamy Naidu, Lecturer in Botany, Dr. V.S Krishna Govt. Degree College(A),Visakhapatnam.

Dr. P. Sara Lecturer in Botany, Govt. Degree College, Ramachandrapuram.

Smt. B. Kumari, Lecturer in Botany, Govt. Degree college for women, Marripalem

Dr D. Madhu Sudhakar, Lecturer in Botany, Govt. Degree college for Men, Kurnool.

"The sea, once it casts its spell, holds one in its net of wonder forever."— **Jacques Cousteau**

Abstract:

The Millennium Ecosystem Assessment (MEA) and the Common International Classification of Ecosystem Services (CICES) are the two main classification schemes that can be used to categorize ecosystem services. The ecosystem services are separated into four main service clusters: providing, cultural, regulating, and sustaining. However, the "MEA supporting services" are viewed by the CICES system as an organism's intrinsic function rather as an ecosystem service. Therefore, the provisioning, regulating and cultural CICES ecosystem services that one organism provides are all based on one function. These ecological services can be examined for the species of plants, animals, or environment. The blue-green economy and climate change are making seaweeds, frequently referred to as marine macro algae, one of the most significant organisms in estuary and seawater habitat ecosystems. Throughout the beginning, seaweeds and humans have been connected, mostly because they provide food, textiles, biochemicals, natural medicine, ornamental materials, inspiration for art, and aesthetic qualities in many coastal communities. These are also being researched as carbon sequestration, green carbon, and potential sources for the pharmaceutical and biomedical industries. The ecological functions that seaweeds offer, their effects on human existence, and the preservation of ecosystem condition are all succinctly reviewed here.

Key words: Millennium Ecosystem Assessment, Ecological services, The blue-green economy, climate change, Carbon sequestration

https://doi.org/10.56975/ijcrt.v13i8.292525

Introduction :.

Seaweeds are phototrophs, as they thrive in shallow seas with light penetration and get their energy from photosynthesis. Seaweed comes in a variety of forms. A significant group of seaweeds are kelps which are big brown algae belonging to the order Laminariales. The two environmental factors that determine the ecology of seaweeds are sunlight for photosynthesis and aquatic environments with salinity levels above 3 PSU. As a result, the chemistry, productivity, and microbial assemblages of seawater were all significantly impacted by kelp forests. As a result, the variety of carbon and nitrogen cycling pathways was also improved. (Pfister, C. A., Altabet).

In deep sea, coastal and estuary conditions, where light and nutrients are the only factors limiting the growth and establishment of these communities, seaweeds are essential for the formation of submerged vegetation habitats. Seaweeds serve as major suppliers of carbon dioxide and oxygen, offer structural frameworks for fish and invertebrates to dwell and hide, and are crucial suppliers of reef sand and food for many herbivores. Therefore, the herbivorous fish and the invertebrates that consume them, as well as the carnivorous (meat-eating) fish that consume the seaweeds, would all perish if the seaweeds disappeared. Because of the numerous ecosystem services they provide, seaweeds have long been cultivated by humans. As a result, they are crucial to the longevity and health of ecosystems (García-Poza, S., Pacheco).

The ecological roles of seaweeds and their effects on the ecosystem are threatened by a number of issues, most of which are caused by human activity. These issues include coastal development, pollution of aquatic habitats and environments, human industrial and commercial activities, climate change, sea level rise, invasive species and reduced water quality. Hence, these artificial disruptions impact seaweed forests, primarily the seaweeds that constitute the canopy, called kelps (big brown seaweeds), which encourage the emergence of invasive and opportunistic organisms. The scientific community has recognized the ecological importance of seaweeds by evaluating the ecosystem services they offer, such as regulating, provisioning and cultural functions that either directly or indirectly promotes human well-being (Pacheco, D., Araújo).

Ecosystem Services Provided by Seaweeds:

The Millennium Ecosystem Assessment (MEA) defines ecosystem services. They are separated into four groups viz. **Supporting services, Provisioning services, Regulating services and Cultural services.**

Supporting services for organism functions are reclassified under the Common International Classification of Ecosystem Services (CICES), which divides services into three categories: providing, regulating, and cultural services. (Gomes, E., Inácio)

Supporting services

The functions and services provided by the organism serve as the basis for all others and their advantages to humans are either gradual or indirect (for instance, primary production and photosynthesis)(Gomes,E.,Inácio).
Sediment formation or soil formation-- Boost seaweed primary productivity and the quality of the aquatic plant habitat. Biomass and oxygen are produced by photosynthesis. Initial manufacturing - Biomass for trophic tiers higher Oxygen production and the provision of appropriate habitat for fish and other human-used organisms. Water purification and food webs indirectly benefit from nutrient cycling, which maintains ecosystem functioning. Seawater equilibrium is impacted by water cycling, habitat provision, biodiversity preservation and higher trophic level biomass production.
Regulating services

Climate regulation: Limit the effects of climate change worldwide Regulation of erosion, protection of shorelines and coastlines, and enhancement of water quality Waste management and water filtration, both in natural settings and in treatment facilities water quality improvement through the removal of contaminants and nutrients Transmission of types that support aquaculture through genetic resources

 © 2025 IJCRT | Volume 13, Issue 8 August 2025 | ISSN: 2320-2882
https://doi.org/10.56975/ijcrt.v13i8.292525

Disease: Reducing germs to improve the quality of water
Water quality, pollution, and community integrity are all indicated by environmental monitoring. The process of atmospheric oxygen production by absorbing CO_2 that has dissolved in water, seaweeds create carbon-based compounds and atmospheric O_2.

Provisioning services

Fiber: Transporting a variety of goods
Food - Provision of wild plant items and sea vegetables
Pharmaceuticals, biochemicals and natural remedies-Transport of essential substances for human well-being.

Cultural services

Educational value: Supports critical thinking and human development.
Values of aesthetics: Promotes human introspection.
Ecotourism and leisure benefits to the local inhabitants and society including economic ones.
Values of cultural heritage facilitates the introspective growth of humans.
Inspiration - Promotes human self-reflection and growth. Social wellbeing is benefited by the local knowledge system.

“Spiritual and religious services” - Benefits that are not physical "Regulating services" are the benefits that come from controlling ecological processes, like the climate, water, and illnesses that affect humans. In contrast to provisioning services, which are "products obtained from ecosystems, such as genetic resources, food and fiber, and fresh water," cultural services are "the non-material benefits people obtain from ecosystems, such as cognitive development, reflection, recreation, and esthetic practice."(1023) Thomaz, S. M. Despite providing a multitude of ecosystem benefits, seaweeds

Fig-1: Seaweeds

SOCIAL, ECONOMIC AND ENVIRONMENTAL CONTRIBUTION OF SEA WEEDS

1. Food and food additives: The nutritional value of seaweeds utilized for human consumption is typically higher. Macroalgae can include anywhere from 7 to 31% protein by dry weight and 2 to 13% lipid by dry weight. Additionally, they have a significant carbohydrate content (up to 32–60% of dry

https://doi.org/10.56975/ijcrt.v13i8.292525

weight). In terms of the macroalgae content in micronutrients, they are an excellent source of vitamins, particularly the lipophilic vitamins A and E and the representatives of the B-group (i.e., B_1, B_{12}) (Biris-Dorhoi, E. S., Michiu) Alginate from *Laminaria/Saccharina* and other brown seaweeds, carrageenan from *Kappaphycus/Eucheuma* and other carrageenophytes, and agar from *Gracilaria* and other agarophytes are seaweed-based (hydro)colloids that are capable of forming gelatins at room temperature and are frequently used as food additives to improve the quality of a variety of foods. (Cai, J., Lovatelli, A., Aguilar-Manjarrez)

2. Nutraceuticals: Iodine, fucoidan, fucoxanthin, and phlorotannins are among the seaweed extracts that are utilized as dietary supplements for their health advantages [2]. Carbohydrates make up over half of the dry weight of macroalgae but because humans lack the enzymes needed to break down these lengthy molecules, they are not absorbed by the digestive tract and instead behave like water-soluble fibers. Because of their rich mineral, vitamin and structural polysaccharide (fiber) content, macroalgae are exceptional dietary supplements that can decrease blood cholesterol and aid intestinal transit. Several health advantages of eating seaweed (Cai, J., Lovatelli, A., Aguilar-Manjarrez)

3. Mitigation of atmospheric CO_2: Lower levels of CO_2 in the atmosphere. Compared to, say, temperate tree plantations or grasslands, which typically have a productivity of less than 1 kilogram C /m2/yr, seaweed communities along the North Atlantic coasts have an annual productivity of about 2 kg C /m2/yr . Evidence supporting seaweeds' ability to trap carbon is growing.

Fig-2: Seaweeds

4. Pharmaceuticals, cosmetics: The primary objective of using macroalgae is to produce phycocolloids, such as **agar**, which are used in the pharmaceutical sector because of their ability to stabilize substances and act as thickeners when extracting chemicals with antiviral, antibacterial, or anti-tumoral characteristics. Because they can prevent the growth of the herpes virus and infection by the human papilloma virus, **carrageenans** are utilized in medicine. Because of their capacity to form a link with keratin, they are also helpful in the treatment and washing of hair. Because of its stability across a broad range of pH and salinity, **alginic acid**, a complex polysaccharide derived from brown algae, is utilized in the medical and cosmetic industries to promote rapid healing and neutralize certain heavy metals or in cases of intoxication by eating. The anti-worm effects of green macroalgae have been utilized. While brown macroalgae are frequently used to treat syphilis, menstrual disorders, hypertension, skin conditions, and gastric ulcers, red macroalgae are used as anticoagulants, anti-worms, and to cure gastritis and diarrhea. (Afflerbach and Froehlich, H. E.)

© 2025 IJCRT | Volume 13, Issue 8 August 2025 | ISSN: 2320-2882
https://doi.org/10.56975/ijcrt.v13i8.292525

5.Eutrophication reduction: Seaweeds' photosynthetic mechanism can help reduce eutrophication by drawing nutrients (phosphorus and nitrogen) from nearby waters. ((Zheng, Y., Jin,),

Fig-3 U*lva* Kelps

6. Genetic resources

One new ecological service that seaweeds provide is genetic resources. Translocation of seedlings derived from wild-type brood stock is becoming more and more popular due to the international seaweed aquaculture industry's explosive growth. Nonetheless, these translocations need to be utilized carefully because imported cultivars may reduce the genetic diversity and structure of wild populations. The genetic structure and connection of target species must be understood in order to make informed decisions regarding aquaculture translocation projects. [Nepper-Davidsen].

7. Aesthetic values ; The aesthetic values are related to other ecosystem services, recreation and ecotourism, which evolves into an eco-friendly and sustainable mindset. Thus, there is ecotourism developing around seaweeds, for example, restaurants that provide local, seasonal, and sustainable food to entrepreneurs that offer "pick your own seaweed" excursions(Merkel, A., Säwe).

8.The use of seaweeds in wastewater treatment: Waste water treatment(WWT) is growing globally and is one of the most commonly used biotic systems to lessen the strain of nutrient eutrophication brought on by wastewater. However, the commercialization of the seaweeds utilized in the WWT is restricted by their physicochemical properties. As a result, this biomass is mostly released into the environment or used to produce electricity, where the risk is deemed to be minimal. But with a higher value, such biomass might be utilized by a number of sectors in pursuit of a circular economy. (Pardilhó, S., Cotas).

9.The Ecological Services of Seaweed in the Future

However, the introduction of non-native species that exhibit invasive behaviour in new settings has put these ecological functions under danger. Considering that the invasive species 'total dystrophy, the overall environment will change to a dangerous level. The fundamental problem in this case is not seaweed species, but rather human activities and acts linked to eutrophication of aquatic ecosystems and climate change. Climate change-induced changes in seaweed distribution, abundance, and community structure will affect how well ecosystems function. The loss of canopy-forming species is predicted to have an impact on the structure and function of food webs by reducing the amount of biogenic habitat and the biodiversity it supports. (Agostini, S., Harvey)

https://doi.org/10.56975/ijcrt.v13i8.292525

10. Climate change adaptation: Coastal ecosystems with vegetation play a crucial role in preventing erosion and flooding along the shore caused by waves and storm surges during harsh weather events, such as hurricanes.Seagrasses are especially good at absorbing wave energy, whereas mangroves and salt marshes are good at absorbing surge energy. These habitats also frequently coexist with salt marshes or mangroves (depending on latitude) in the intertidal zone and seagrass in subtidal areas, which increases their combined ability to defend against waves and surges.(Duarte, C. M., Losada)

Conclusion

This review reveals that seaweeds are essential to the maintenance of many naturally occurring ecosystems that provide several ecological services to humanity. Thus, preserving the status quo in estuarine and coastal areas are required to safeguard both the nature and human life. Additionally, using a variety of plant-native seaweeds to restore estuarine and coastal areas in degraded ecosystems offers substantial benefits to people. Seaweeds lose their capacity to provide ecological services when ecosystems are impacted by human activities (such as eutrophication, damming and species invasions), and in some situations, they may even offer "dis-services" to people.

Furthermore, as there is evidence that the vast majority of the ecological services that may be articulated are more effective in regions with richer and more biologically diversified Ecosystems. Efforts should be made to maintain the biodiversity of seaweeds.

References

1.Pfister, C. A., Altabet, M. A., & Weigel, B. L. (2019). Kelp beds and their local effects on seawater chemistry, productivity, and microbial communities. Ecology, 100(10), e02798.

2. García-Poza, S., Pacheco, D., Cotas, J., Marques, J. C., Pereira, L., & Gonçalves, A. M. (2022). Marine macroalgae as a feasible and complete resource to address and promote Sustainable Development Goals (SDGs). Integrated environmental assessment and management, 18(5), 1148-1161.

3. Pacheco, D., Araújo, G. S., Cotas, J., Gaspar, R., Neto, J. M., & Pereira, L. (2020). Invasive seaweeds in the Iberian Peninsula: A contribution for food supply. Marine Drugs, 18(11), 560.

4M., Bogdzevič, K., Kalinauskas, M., Karnauskaitė, D., & Pereira, P. (2021). Future land-use changes and its impacts on terrestrial ecosystem services: A review. Science of The Total Environment, 781, 146716.

5. Thomaz, S. M. (2023). Ecosystem services provided by freshwater macrophytes. Hydrobiologia, 850(12), 2757-2777.

6. García-Poza, S., Leandro, A., Cotas, C., Cotas, J., Marques, J. C., Pereira, L., & Gonçalves, A. M. (2020). The evolution road of seaweed aquaculture: cultivation technologies and the industry 4.0. International Journal of Environmental Research and Public Health, 17(18), 6528.

7. Biris-Dorhoi, E. S., Michiu, D., Pop, C. R., Rotar, A. M., Tofana, M., Pop, O. L., ... & Farcas, A. C. (2020). Macroalgae—A sustainable source of chemical compounds with biological activities. Nutrients, 12(10), 3085.

8. Cai, J., Lovatelli, A., Aguilar-Manjarrez, J., Cornish, L., Dabbadie, L., Desrochers, A., ... & Yuan, X. (2021). Seaweeds and microalgae: an overview for unlocking their potential in global aquaculture development. FAO Fisheries and Aquaculture Circular, (1229).

9. Froehlich, H. E., Afflerbach, J. C., Frazier, M., & Halpern, B. S. (2019). Blue growth potential to mitigate climate change through seaweed offsetting. Current Biology, 29(18), 3087-3093.

https://doi.org/10.56975/ijcrt.v13i8.292525

10. Zheng, Y., Jin, R., Zhang, X., Wang, Q., & Wu, J. (2019). The considerable environmental benefits of seaweed aquaculture in China. Stochastic Environmental Research and Risk Assessment, 33(4), 1203-1221.

11. Agostini, S., Harvey, B. P., Milazzo, M., Wada, S., Kon, K., Floc'h, N., ... & Hall-Spencer, J. M. (2021). Simplification, not "tropicalization", of temperate marine ecosystems under ocean warming and acidification. Global Change Biology, 27(19), 4771-4784.

12. Nepper-Davidsen, J., Magnusson, M., Glasson, C. R., Ross, P. M., & Lawton, R. J. (2021). Implications of genetic structure for aquaculture and cultivar translocation of the kelp Ecklonia radiata in northern New Zealand. Frontiers in Marine Science, 8, 749154.

13. Merkel, A., Säwe, F., & Fredriksson, C. (2021). The seaweed experience: exploring the potential and value of a marine resource. Scandinavian Journal of Hospitality and Tourism, 21(4), 391-406.

14.Pardilhó, S., Cotas, J., Gonçalves, A. M., Dias, J. M., & Pereira, L. (2021). Seaweeds used in wastewater treatment: steps to industrial commercialization. In Phycology-Based Approaches for Wastewater Treatment and Resource Recovery (pp. 247-262). CRC Press.

15. Duarte, C. M., Losada, I. J., Hendriks, I. E., Mazarrasa, I., & Marbà, N. (2013). The role of coastal plant communities for climate change mitigation and adaptation. Nature climate change, 3(11), 961-968.