Seagrass Bed Ecosystem Service Valuation — A Case Research on Hepu Seagrass Bed in Guangxi Province

HAN Qiuying[1,2], HUANG Xiaoping[2], SHI Ping[1], ZHANG Jingping[2]

1. *Yantai Institute of Coastal Zone Research for Sustainable Development, Chinese Academy of Sciences, Yantai* 264003*, Shandong, China;*
2. *LED, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou* 510301*, Guangdong, China*

Abstract: Seagrass bed ecosystem is a coastal ecosystem with abundant biodiversity and high production. It is also an important system for the sustainable development of human society and economy. Based on the local research, statistical data and prevenient research results, the main services of Hepu seagrass ecosystem were analyzed in the paper, including fishing production, nutrient cycling, scientific research, protecting the coast from eroding, climate regulation, biodiversity, culture, bequest valuation, option valuation and existence valuation and so on. At the same time, we used ecological and economic methods for economic evaluation of seagrass in Hepu of Guangxi, including the market valuation method, contingent valuation method, carbon and tax method, benefit transfer method and expert survey method. The results showed that the total valuation of the Hepu seagrass ecosystem service was about 6.29×10^5 Yuan RMB/ha in 2005. Among these services, the indirect using valuation is the main aspect, which was 4.47×10^5Yuan RMB/ha in 2005, accounting for 70.97 % of the total valuation. The non-using valuation was 1.54×10^5 Yuan RMB/ha in 2005, accounting for 24.52 % of the total valuation. The direct using valuation is the least, which was only 2.84×10^4 Yuan RMB/ha in 2005, accounting for 4.51 % of the total valuation.

Keywords: Seagrass bed; ecosystem service; valuation; Hepu; South China

Introduction

Seagrass bed plays an important role in coastal ecosystem [1], providing significant habitat and food resources for other living marine resources, and having an effect on the circulation of carbon, nitrogen and phosphorus in the world [2-4]. Many natural and human-induced events created disturbances of seagrass in the world [5]. Developing evaluation of seagrass ecosystem has an effect on protecting seagrass ecosystem and strengthening the environment consciousness of people. There is no research on seagrass and few paper about study on the evaluation of seagrass compared with mangrove and coral reef. Watson researched the economic valuation of prawn produced by seagrass in the Cairns Bay [6]. Costanza evaluated the valuation of nutriment circulation and material production of seagrass [7].

Received on December 10, 2007

Evaluation on seagrass is in the initiatory phase in China. Li [8] and Huang [9] researched the valuation of seagrass in Li'an Port of Hainan Island and Hepu of Guangxi Province, but they only evaluated the valuation of fishing production, ecosystem nutrient cycling, protecting the coast from eroding of seagrass, and did not research the climate regulation and biodiversity valuation.

According to modern ecological economics, the ecological service valuation of seagrass includes direct using valuation, indirect using valuation and non-using valuation [10]. Direct using valuation mainly includes marine culture and tidal flat fishing valuation produced by seagrass. Indirect using valuation includes offshore fishing, protecting the coast from eroding, climate regulation, biodiversity, scientific research and ecosystem nutrient cycling and purifying seawater valuation, which aren't used in production and consumption directly. Non-using valuation includes bequest valuation, option valuation and existence valuation [11]. Based on local statistical data, prevenient research results and the characters of Hepu seagrass ecosystem in Guangxi Province, the main service valuation of Hepu seagrass ecosystem was analyzed in the paper, which would provide the scientific foundation for the sustainable use of Hepu seagrass ecosystem in Guangxi.

1 Study methods

1.1 Introduction of study area

Hepu seagrass bed about 540 ha (in 2002) was located in the marine area of Hepu County in Guangxi (Fig.1). There were *Halophila ovalis*, *Zostera japonica*, *Halophila beccarii* and *Halodule uninervis*, et al., and *Halophila ovalis* were the dominant species [9]. The average coverage ratios of *Halophila ovalis* in Xialongwei and Shabei seagrass bed were respectively 38.8 % and 41.5 % [8]. Hepu seagrass is located in the *Dugong dugon* National Nature Reserve of Hepu. *Halophila ovalis* is the food resource of *Dugong dugong*. In recent years, Hepu seagrass bed has been interrupted badly, including digging clamworms and shells, marine culture, as well as typhoon and storm tide, and the degradation trend was evident.

1.2 Evaluation methods

1.2.1 Market valuation method

Market valuation method evaluates the seagrass valuation according to the market price of the production produced by seagrass, which is used to evaluate the valuation of the marine culture and tidal flat fishing. Based on the statistical data from Statistics Bureau, Shatian Town and Shankou Town in Hepu County, fishing earning was 1.73×10^9 Yuan RMB in Hepu County in 2005, in which offshore fishing earning was 5.43×10^8 Yuan RMB, and the area of marine culture was 800 ha, and marine culture earning was 6.17×10^4 Yuan RMB /a·ha. And offshore fishing earning was 2.03×10^8 Yuan RMB in Shatian Town and Shankou Town.

Fig.1 Distribution of seagrass in Hepu of Guangxi

1. Salt field seagrass bed in Beimu 2. Gaoshatou seagrass bed 3. Shabei seagrass bed
4. Xialongwei seagrass 5. Danshuikou seagrass bed 6. Ronggenshan seagrass bed
7. Shanliao seagrass bed 8. Yingluo port seagrass bed

1.2.2 Carbon and tax method

Seagrass can absorb CO_2 and release O_2. According to the photosynthesis equation of plants, synthesizing 1 g dry substance can absorb 1.629 g CO_2, and release 1.1914 g O_2 [12]. The economic valuation of seagrass absorbing CO_2 and releasing O_2 can be calculated on the basis of the overseas and domestic fee standard of releasing CO_2 and the cost making O_2 [13].

1.2.3 Benefit transfer method

Benefit transfer method is a method that cites the results of other interrelated projects, when a project is short of benefit numerical valuation, adequate funds, time and manpower [14]. This study mainly cited the study results from Costanza and the special report of Chinese seagrass. For example, Costanza gained that the ecosystem nutrient cycling valuation of seagrass in the world was 19 002 $/a·ha and the science research valuation of coastal zone in the world was 62 $/a·ha [7]. The special report of Chinese seagrass gave that the tidal flat fishing earning of seasgrass bed area in Hepu County was 9 733 Yuan RMB/a·ha [9].

1.2.4 Contingent valuation method

Contingent valuation method is a normal method that is used to conclude the willing-to-pay of the public to environment resources, and consequently gains the bequest valuation, option valuation and existence valuation of resources [15]. In this study, we sent out 500 questionnaires to the householders in the Hepu County, received 421 effective questionnaires and gained the willing-to-pay of every householder for protecting the limited seagrass resources. The average willing-to-pay (E (WTP)) can be calculated by mathematical expectation formula of discrete variables:

$$E(\mathrm{WTP}) = \sum_{i=1}^{n} A_i P_i$$

A_i—Bid account $10 \leq A_i \leq 1000$ Yuan RMB

P_i—Probability of visited person selecting the account $0 \leq P_i \leq 1$

n—Selected probability numbers $n = 25$

1.2.5 Expert survey method

Expert survey method is a method that evaluates seagrass valuation using the knowledge, experience and analyses the ability of experts who are surveyed. In this study, we sent out 300 questionnaires to the experts studying seagrass and ecological economics, and received 128 effective questionnaires. The problems of the expert questionnaire mainly included the contribution ratio of seagrass to marine culture, tidal flat fishing and offshore fishing, percentage of seagrass reducing the cost repairing coast, and biodiversity valuation of seagrass of each ha. These parameters can be calculated by discrete variable:

$$C = \sum_{i=1}^{n} A_i P_i$$

P_i—Probability of visited person selecting the account $0 \leq P_i \leq 1$

n—Selected probability numbers $n = 10$

In the expert questionnaire, the contribution ratio of seagrass to the marine culture ranged from 10 % to 90 %, the contribution ratio to the tidal flat fishing ranged from 10 % to 90 %, the percentage of reducing the cost for repairing coast ranged from 10 % to 90 %, the biodiversity valuation of seagrass ranged from 10 $/a·ha to 10000$/a·ha.

According to the former formula, the contribution ratios of seagrass to the marine culture, tidal flat fishing and offshore fishing were respectively 32.8 %, 84.3 % and 45.6 %. The percentage of seagrass of reducing the cost for repairing coast was 45.9 %. The biodiversity valuation of seagrass was 8000 $/a·ha in 2005. If 1 $ can be exchanged into 8 Yuan RMB, the biodiversity valuation of seagrass was 64 000 Yuan RMB/a·ha in 2005.

2 Results

2.1 Direct using valuation

2.1.1 Marine culture valuation

The calculated formula was $L_1 = C_1 W_1$, where,

L_1—the marine culture valuation produced by seagrass of each ha

C_1—the contribution ratio of seagrass to the marine culture

W_1—the marine culture valuation of each ha in marine area of seagrass

From the former formula, the marine culture valuation of seagrass in Hepu was 2.02×10^4 Yuan RMB/a·ha in 2005.

2.1.2 Tidal flat fishing valuation

The calculated formula was $L_2 = C_2 W_2$, where,

L_2—the tidal flat fishing valuation produced by seagrass every ha

C_2—the contribution ratio of seagrass to the tidal flat fishing

W_2—the tidal flat fishing earning of each ha in marine area of seagrass

The tidal flat earning in the seagrass area was 9733 Yuan RMB/a·ha in 2005 [9]. From the former formula, the tidal flat fishing valuation produced by seagrass in Hepu was 8.20×10^3 Yuan RMB/a·ha in 2005.

2.2 Indirect using valuation

2.2.1 Offshore fishing valuation

The calculated formula was $L_3 = C_3 W_3$, where,

L_3—the offshore fishing valuation produced by seagrass

C_3—the contribution ratio of seagrass to the offshore fishing

W_3—the catching fishing earning in Shatian Town and Shankou Town

The offshore fishing valuation produced by seagrass in Hepu was 9.26×10^7 Yuan RMB/a in 2005. The seagrass area in Hepu was 540 ha in 2005. So the offshore fishing valuation produced by seagrass was 1.71×10^5 Yuan RMB/a·ha in 2005.

2.2.2 Valuation protecting the coast from eroding

The calculated formula was $L_4 = C_4 W_4$, where,

L_4—the valuation protecting the coast from eroding produced by seagrass in Hepu

C_4—cost for repairing every year in seagrass area if there is no seagrass

W_4—the percentage of seagrass reducing cost repairing coast

$W_4 = W'_4/(1 - C_4)$

W'_4—actual repairing cost in the seagrass area every year

According to the questionnaire to the Hepu County government, there were 700 people to protect

the coast from eroding, and everyone gained the subsidy of 10000 Yuan RMB. The other cost for repairing was 2.20×10^6 Yuan RMB/a. The valuation protecting the coast from eroding produced by seagrass was 7.81×10^6 Yuan RMB /a in 2005. The seagrass area in Hepu in 2005 was 540 ha. So the valuation protecting the coast from eroding produced by seagrass was 1.45×10^4 Yuan RMB/a·ha in 2005.

2.2.3 Climate regulation valuation

The calculated formula was $L_5=f(x_{51})+f(x_{52})$, where,

$f(x_{51})$—the valuation of Hepu seagrass absorbing CO_2

$f(x_{52})$—the valuation of Hepu seagrass releasing O_2

The average dry mass of seagrass bed in Hepu was 25.5 g/m^2 [9], that is, 0.255 t/ha. We can gain seagrass in Hepu absorbing 0.415 t/ha CO_2, in which there was 0.113 t/ha C, and releasing 0.304t O_2. Based on the current international standard of carbon tax rate and Chinese situation, the mean between the forestation cost, which was 250 Yuan RMB/t, and international standard of carbon tax, which was 150 $/t, was used as carbon tax standard. It was 770 Yuan RMB/t [16]. The valuation of Hepu seagrass absorbing CO_2 was 87.01Yuan RMB/a·ha. The cost of making O_2 in industry was 400 Yuan RMB/a [17]. The valuation of Hepu seagrass releasing O_2 was 121.6 Yuan RMB/a·ha. The climate regulation valuation of Hepu seagrass was 208.61 Yuan RMB/a·ha in 2003. If the discount rate was 5 %, the climate regulation valuation of Hepu seagrass was 2.30×10^2 Yuan RMB/a·ha in 2005.

2.2.4 Biodiversity valuation

According to the former expert survey method, the biodiversity valuation of seagrass was 64000Yuan RMB/a·ha in 2005. On the basis of the standard of important species habitat function offered by international wetlands and their ecological benefit (Tab.1) [18], the area and rare species account number in seagrass bed in Hepu, the grade of the Hepu seagrass bed was confirmed and the controlling cost was gained. There were *Dugong dugon*、*Chelonia mydas* and *Hippocampus trimaculatus* in the rare species of Hepu seagrass bed. That made the habitat function of Hepu seagrass in the grade from 3 to 4 and the controlling cost was from 10×10^4 $ to 100×10^4 $. Based on area proportion, the controlling cost in Hepu seagrass was 5.4×10^5 $. If exchange rate was that 1 $ was changed into 8 Yuan RMB, the controlling cost in Hepu seagrass was 4.32×10^6 $. The biodiversity valuation can be 4.32×10^6 Yuan RMB/a, that is 8 000 Yuan RMB/a·ha.

The mean of two former methods was 3.6×10^4Yuan RMB/a·ha, which was the biodiversity valuation of Hepu seagrass.

2.2.5 Scientific research valuation

Scientific research valuation is usually evaluated according to the scientific research investment and the factual cost of scientific researchers [12]. Because the seagrass research in China was at the initiatory stage and scientific research cost is much less than actual scientific research valuation, we used the mean

of scientific research valuation of the world and China to evaluate the seagrass valuation in Hepu. Costanza thought that the scientific research valuation of global coastal zone ecosystem was 62 $/a·ha in 1997 [7]. If the exchange rate was that 1 $ was changed into 8 Yuan RMB and the discount rate was 5 %, the scientific research valuation of global coastal zone ecosystem was 732.79 $/a·ha in 2005. Chen concluded that the average scientific research valuation of Chinese ecosystem was 382 Yuan RMB/a·ha in 2000[19]. If the discount rate was 5 %, the scientific research valuation of Chinese ecosystem was 487.51 Yuan RMB/a·ha in 2005. We thought that the mean of the scientific research valuation of Chinese ecosystem and global coastal zone ecosystem, which was 6.10×10^2 Yuan/a·ha, was the scientific research valuation of Hepu seagrass in 2005.

Tab.1 The criteria and ecological benefits of the function providing habitats for the wildlife of wetlands

Level	Area	Numbers of rare species	Controlling cost /×10⁴$
1	＞100 000	＞10	＞10 000
2	＞10 000	＞8	＞1 000
3	＞1 000	＞4	＞100
4	＞100	＞2	＞10
5	＜100	＜2	＜10

2.2.6 Ecosystem nutrient cycling valuation

There has been no interrelated studies on the nutrient cycling process of seagrass ecosystem in Hepu. In this study, the result of Costanza(1997) was adopted, whose study gained the ecosystem nutrient cycling valuation was 19002 $/a·ha [7]. If the exchange rate was that 1 $ was changed into 8 Yuan RMB and the discount rate was 5 %, the ecosystem nutrient cycling valuation of Hepu seagrass was 2.24×10^5 Yuan RMB/a·ha in 2005.

2.2.7 Purifying seawater valuation

In this study, the total nitrogen (TN) and total phosphorus (TP) were calculated. The ratio of C:N:P in seagrass ecosystem was 474∶24∶1[20]. According to the former study, seagrass in Hepu absorbed 0.415 t/ha CO_2 in which there was 0.113t/ha C every year, so the mass of nitrogen in Hepu seagrass was 5.72×10^3 t/a·ha and the mass of phosphorus was 2.38×10^4 t/a·ha. The cost of wiping off pollution of TN was 2.66×10^4 Yuan RMB/t and the cost of wiping off pollution of TP was 55.86×10^4 Yuan RMB/t in 2003 [16]. The purifying seawater valuation of Hepu seagrass was 287Yuan RMB/a·ha in 2003. If the exchange rate was that 1 $ was changed into 8 Yuan RMB, the purifying seawater valuation of Hepu seagrass was 3.16×10^2 Yuan RMB/a·ha in 2005.

2.3 Non-using Valuation

According to the contingent valuation method, the willing-to-pay of every householder for protecting the limited seagrass resources was 143 Yuan RMB/a. Based on the result from developed countries, the willing-to-pay of non-household to scenic spots and the wild areas was from 9$ to 107$/a [21]. If the exchange rate was that 1 $ was changed into 8 Yuan RMB, the mean of the 3 former numbers was 357

Yuan RMB/a, which was thought as the willing-to-pay of every household to Hepu seagrass. On the basis of the statistical data from Statistics Bureau, there were 23 3266 households in Hepu County. The non-using valuation of Hepu seagrass was 8.33×10^7Yuan RMB/a in 2005, which was 1.54×10^5 Yuan RMB/a·ha.

Based on the former evaluation on Hepu seagrass bed ecosystem service, the total valuation of seagrass bed ecosystem service in Hepu was 6.29×10^5 Yuan RMB/a·ha in 2005, in which direct using valuation was 2.84×10^4 Yuan RMB/a·ha, and indirect using valuation was 4.47×10^5 Yuan RMB/a·ha and non-using valuation was 1.54×10^5 Yuan RMB/a·ha (Tab.2).

Tab. 2 The valuation of Hepu seagrass bed

Valuation type	Service function	Evaluation method	Evaluation result/$\times 10^2$ Yuan RMB/a·ha
Direct using valuation	Marine culture	Market valuation method expert survey method	202
Indirect using valuation	Tidal flat fishing	Market valuation method	82
	Offshore fishing	Market valuation method expert survey method	1710
	Protecting the coast from eroding	Expert survey method	145
	Climate regulation	Carbon and tax method	2.30
	Biodiversity	Benefit transfer method and expert survey method	360
	Scientific Research	Benefit transfer method	6.10
	Ecosystem Nutrient Cycling Value	Market valuation method benefit transfer method	2240
	Purifying Seawater	Market valuation method	3.16
Non-using valuation	Bequest valuation, option valuation and existence valuation	Contingent valuation method benefit transfer method	1543
Total valuation	—	—	6293.56

Tab.3 The percentage of Hepu seagrass ecosystem valuation

Valuation type	Evaluation result /$\times 10^2$Yuan RMB/a·ha	Percentage of the total valuation
Direct using valuation	284	4.51 %
Iindirect using valuation	4466.56	70.97 %
Non-using valuation	1543	24.52 %
Total valuation	6293.56	100 %

3 Discussion

The ecosystem service valuation of Hepu seagrass bed was mainly indirect using valuation and non-using valuation, which accounted for 95.49 % of total economic valuation (Tab.3). Offshore fishing and ecosystem nutrient cycling valuation were especially biggish, which respectively accounted for 27.17 % and 35.59 %, this reflecting the significance of seagrass to the offshore fishing and ecosystem nutrient cycling. The direct using valuation only accounted for 4.51 % of total economic valuation of Hepu seagrass. The main threats of Hepu seagrass were digging clamworms and shells, and marine culture. For the sustainable use of Hepu seagrass, the fishery activities endangering seagrass bed in Hepu should be managed well.

In this study, the total valuation of seagrass bed ecosystem service in Hepu was 6.29×10^5Yuan RMB/a·ha in 2005, which was obviously higher than the result from other studies in China [9]. It was because that the climate regulation valuation, biodiversity valuation, purifying seawater valuation and scientific research valuation were evaluated, which were not evaluated in other studies in China [9].

From the former study, the total valuation of seagrass ecosystem service in Hepu was 6.29×10^5 Yuan RMB/a·ha in 2005. This showed that the seagrass ecosystem service function was very important, which didn't accord with the scientific research investment and recognition degree to seagrass in China. Chinese government should promote the protection and scientific research investment.

The research on the ecological benefit of seagrass in China was at the initiatory stage. The error of the statistical data and the difference of evaluation methods may bring the error of evaluation results. Because of few researchers on seagrass in China, the expert questionnaires were sent out to the overseas experts studying seagrass and ecological economics in this study. The research result, impacted by Chinese situation and people's conception, may have some errors. The study needs more discussion.

Acknowlegements

This project was supported by the Innovative Engineering Project of Chinese Academy of Sciences (Grant No.KSCZ2-SW-132), United Nations Environment Program/Global Environment Fund (UNEP/GEF) (Grant No. UNEP/GEF/SCS/Chi/MoU2c), Project of Science and Technology Development Plan in Shandong Province (Grant No. 2007GG2Q706019).

References

[1] Nagelkerken I, Velde G, Gorissen M W, et al. Importance of mangroves, seagrass beds and the shallow coral reef as a nursery for important coral reef fishes, using a visual census technique[J]. Estu. Coast. shelf sci., 2000, (51): 31-44.

[2] Den H C. The sea grasses of the world [M]. Amsterdam: North Holland Publication. 1970. 275.

[3] Edgar G J. Comparisons of species richness, size-structure and production of benthos in vegetated and unvegetated habits in Western Port, Victoria [J]. J. Exp. Mar. Bio. Eco., 1994, (176): 201-226.

[4] Fortes M D. Mangroves and seagrass beds of East Asia: habitat under stress [J]. Ambio, 1988, (17): 207-213.

[5] Frederick T S, Sandy W E. Natural and human-induced disturbance of seagrasses [J]. Environ. Cons., 1996, 23(1): 17-27.

[6] Watson R A, Coles R G, Lee W J. Stimulation estimates of annual yield and landed value for commercial penaeid prawns from a tropical seagrass habitat, Northern Queensland, Australia [J]. Jour. Mar. Freshwater Res., 1993, (44): 211-219.

[7] Costanza R, d'Arge R, de Groot R, et al. The value of the world's ecosystem services and natural capital [J]. Nature, 1997, (387): 253-260.

[8] Li Y H. Study on the ecological characters, service function and protection of Hepu seagrass bed in Guangxi [D].

South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2004.

[9] Huang X P, Huang L M, Li YH, et al. the special report of Seagrass in China [R]. South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2005.

[10] James S. The scsio-economic costs and benefits of coastal habitat rehabilitation and creation [J]. Mar. Pollu. Bul., 1999, (37): 373-382.

[11] Helena M. Compensation for landowners affected by mineral development: the Fijian experience [J]. Resour. Policy, 2000, (26): 115-125.

[12] Xin K, Xiao D N. Wetland ecosystem service valuation——a case researches on Panjin area. Acta Ecologica Sinica, 2002, 22(8): 1345-1349.

[13] Thomas P S. The use of biological criteria as a tool for water resource management [J]. Environ. Sci. Policy, 2000, (3): 43-49.

[14] Cui B S, Yang Z F. Benefit valuation of typical wetlands in Jilin Province [J]. Resour. Sci., 2001, 23(3): 55-61.

[15] Mitchell R, Carson R. Using surveys to value public goods: The contingent valuation method [M]. Washington D C: Resources for the future. 1989.

[16] Zhuang D C, Ou W X, Ding D S. Evaluation of lake recovery area eco-economy benefit in Dongting Lake wetland [J]. J. Nat. Resour., 2003, 18(5): 536-543.

[17] Pan W B, Tang T, Deng H B, et al. Lake ecosystem services and their ecological valuation——a case study of Baoan Lake in Hubei Province [J]. Chin. J. Appl. Ecol., 2002, 12(10): 1315-1318.

[18] Xiao D N, Hu Y M, Li X Z. Study on scape ecology of delta wetland around Bohai [M]. Beijing: Science Publishing Company. 2001. 368-389.

[19] Zhang Z X, Zhang X S. The valuation of ecosystem benefit in China [J]. Chin. Sci. Bul., 2000, 45(1): 17-22.

[20] Duarte C M. Seagrass nutrient content [J]. Mar. Eco. Pro. Ser., 1990, (67): 201-207.

[21] Adger W N, Brown K, Cervigni R, et al. Total economic value of forests in Mexico [J]. Ambio, 1995, 24(5): 285-295.

广西合浦海草床生态系统服务功能价值评估

韩秋影[1,2]，黄小平[2]，施平[1]，张景平[2]

（1. 中国科学院烟台海岸带可持续发展研究所，山东 烟台，264003；

2. 中国科学院南海海洋研究所热带海洋环境动力学重点实验室，广东 广州，510301）

摘 要： 海草床生态系统是生物多样性丰富和生产力高的近岸海洋生态系统，本文以广西合浦海草床为例，结合实地调查、已有的研究成果和当地统计资料，综合运用生态经济学、资源经济学等基本理论和方法，对该地区海草生态系统的服务功能进行了价值评估。结果表明 2005 年该地区海草生态系统的服务功能价值为 6.29×105 元/a•ha，其中间接利用价值最大，为 4.47×105 元/a•ha，占总经济价值的 70.97 %；其次为非利用价值，为 1.54×105 元/a•ha，占总经济价值的 24.52 %；最少的是直接利用价值为 2.84×104 元/a•ha，仅占总经济价值的 4.51 %。

关键词： 海草床；生态系统服务；价值评估；广西合浦