Report on the feasibility study towards assessment of seagrass distribution in the NOWPAP region

1. Backgrounds

Since its inception, Special Monitoring and Coastal Environmental Assessment Regional Activity Centre (CEARAC) has implemented various activities focusing on assessment of the state of the marine, coastal and associated freshwater environments. Since 2007, when the mid- and long-term strategies of CEARAC was developed, CEARAC has expanded its working areas from NOWPAP Working Group 3 (red tide and harmful algal blooms) and Working Group 4 (ocean remote sensing) to assessment of the status of eutrophication and development of new environmental assessment methods in the coastal areas using biological diversity as a main indicator. In the 2014-2015 biennium, three projects were implemented based on the outcomes of past activities and in line with the CEARAC mid- and long-term strategies: (1) pilot assessment on the impacts of major threats to marine biodiversity in selected sea areas in the NOWPAP region; (2) trial applications of the screening procedure of the NOWPAP Common Procedure for eutrophication assessment; and (3) case studies on seagrass mapping in selected sea areas in the NOWPAP region.

In case of CEARAC's activity on eutrophication assessment, firstly, a common procedure to be used among the NOWPAP member states was developed (2008-2009). Next, eutrophication assessment was conducted in some selected sea areas in each NOWPAP member state (2010-2013) with the developed procedure. Then, in the 2014-2015 biennium, eutrophication assessment of the entire NOWPAP region was carried out although the used parameters were limited. With this transboundary assessment, an interactive web-based map of potential eutrophic zones in the NOWPAP region was constructed upon the website of Marine Environmental Watch project and it is being reviewed by the member state (UNEP/NOWPAP/CEARAC/FPM 14/Ref1). As eutrophication assessment started from the selected sea areas and expanded to the entire NOWPAP region, other CEARAC activities should also widen its geographical working area despite limitations of both financial and human resources.

Through case studies on seagrass mapping in the selected sea areas in the NOWPAP region in 2014-2015, a manual for seagrass and seaweed beds distribution mapping with satellite images, which was developed by Dr. Teruhisa Komatsu, was validated. Then, the next step expected would be to apply the developed methodology to the entire NOWPAP region. Although seagrass and seaweed beds are important in terms of their functions to maintain marine biodiversity and mitigate climate change, information on their distribution is very limited.

Thus, a proposal to conduct feasibility study towards assessment of seagrass in the NOWPAP region was proposed as an activity of CEARAC in the 2016-2017 biennium. The proposal was then reviewed and adopted at the 13th CEARAC FPM held on 25-26 August 2015 in

Toyama. CEARAC workplan and budget including this proposal was then approved at the 20th NOWPAP Inter Governmental Meeting (28-30 October 2015, Beijing, China).

2. Objective

Objective of this activity is to investigate the feasibility for assessment of seagrass distribution in the NOWPAP region, including identifying obstacles and required resources and/or tasks for implementing the assessment.

3. Tasks

3.1 Review of literatures on seagrass distribution and threats to seagrass

The following national experts nominated by CEARAC FPs (table 1) concluded MoUs for collection and review of literatures on seagrass distribution and threats to seagrass in each member state. Collected information was organized in accordance with a tabular format CEARAC prepared (Annex 1). Analyzing collected information with spatial and temporal scale will further identify dominant seagrass species and their distribution, and threats to seagrass in the NOWPAP regions.

Through the literature review process, applicability of remote sensing techniques to detect identified threats will also be reviewed for future monitoring.

Table 1. List of national experts who conduct review of literatures on seagrass distribution and threats to seagrass in the NOWPAP region

Country	Organization	Experts
China	State Key Laboratory of Tropical Ocenography, South China Sea Institute of Oceanology, Chinese Academy of Sciences	Dr. Dingtian Yang
Japan	Department of Commerce, Yokohama College of Commerce	Dr. Teruhisa Komatsu
Korea	Korea Ocean Satellite Center, Korea Institute of Ocean Science and Technology	Dr. Jong-Kuk Choi
Russia	Pacific Geological Institute, Far Eastern Branch of the Russian Academy of Sciences	Dr. Vasily Zharikov

3.2 Development of a seagrass database in the NOWPAP region

CEARAC will construct a database of seagrass based on collected literature information in section 3.1. The database will include author names, year, title of publication, abstract, type of publication (paper, report, book, etc.), name of journal, volume, pages, seagrass species, name of location, coordinates (latitude and longitude), threats to seagrass and availability of GIS polygon data. Structure of the database is being designed for construction of the database upon the website of Marine Environmental Watch project. The database will have a function for its users to easily and voluntarily update information so that organizations and/or groups which work for restoration of seagrass can monitor their efforts in conservation and restoration of seagrass. Involvement of organizations/groups will be promoted through possible opportunities such as the National Amamo (seagrass) Summit in Japan or other meetings of NGOs that promote conservation and restoration of seagrass in the NOWPAP region. Collected information in the database will also be registered to Ocean Biogeographic Information System (ORBIS).

3.3 Estimation of image analysis cost

CEARAC has estimated the cost of image analysis to assess seagrass distribution in the NOWPAP region based on the case studies in the selected sea areas in the 2014-2015 biennium (Annex 2). Analysis of satellite images is a long-time process. The whole processes include selecting and obtaining satellite images from spaces agencies, carrying out sea truth survey or collecting existing field data, preparing training data sets for classification, removing sun glint, correcting radiance by depth, classifying images and assessing accuracy of obtained classification results. Considering the costs and time spent to study the distribution of seagrass in the selected sea areas in the NOWPAP region, it is not realistic to apply the same conventional method to study the distribution of seagrass in the coastal area of the whole NOWPAP region.

While cost of purchasing some commercial satellite sensors' images are expensive, there are freely available satellite sensors that can be used for detecting seagrass. In the case studies in Nanao Bay, Jangheung Bay and eastern section of the Far Eastern Marine Reserve in Russia. satellite images of NASA Landsat optical sensors such as Thematic Mapper, Enhanced Thematic Mapper Plus and Operational Land Imager were used to study distribution of seagrass. Although spatial resolution of these Landsat optical sensors is up to 30 m, these sensors can detect seagrass beds that distribute in a large scale. Spatial limitation of freely available satellite sensors is improving up to 10 m with the advent of Multispectral Imager (MSI) on board Sentinel-2 satellite of European Space Agency that has similar wavelengths and the same geographic coordinate system as the Landsat optical sensors.

Thus, it is expected to start using freely available satellite sensors for detection of seagrass beds in coastal area of the whole NOWPAP region. Reducing the time and manpower cost to analyze satellite data is other things which need to be considered.

3.4 Organization of International Workshop on assessment of seagrass distribution in the Northwest Pacific region

First international workshop on assessment of seagrass distribution in the NOWPAP region was organized in Himi, Toyama, Japan on August 3, 2017 with inviting researchers in and out of the NOWPAP region. 30 people including local scientists, local government officers and NGO members involved in restoring seagrass participated in the workshop.

Dr. Maria Potouroglou of UNEP/GRID-Arendal gave a keynote speech titled “Carbon Storage Potential of Blue Forest: prospects for developing blue carbon initiatives in the NOWPAP region”. Dr. Teruhisa Komatsu of Yokohama College of Commerce gave another keynote speech titled “Estimating candidate EBSA for seagrasses and projecting future distribution of seagrasses in Japan.” Country reports on the status of seagrass distribution and threats to seagrass in the NOWPAP region was presented by the nominated national experts who are involved in the literature review in section 3.1. Dr. Tatsuyuki Sagawa of Remote Sensing Technology Center of Japan presented “Large scale seagrass mapping using satellite images in Japan and Dr. Gregory N. Nishihara of Nagasaki University presented “Monitoring seagrass productivity using low-cost data logging technology”.

At the end of the workshop, provisional table of contents of the feasibility study report was presented by CEARAC and required future actions for mapping distribution of seagrass in the NOWPAP region was discussed among the participants. Consensus was formed on the use of freely available satellite images, cloud computing technology and involvement of the public to collect field survey information.

3.5 Publication of a feasibility study report.

Based on the tasks from 3.1-3.4, CEARAC will prepare and publish a feasibility study report including future actions for assessment of seagrass distribution in the NOWPAP region and share it among the NOWPAP member states as well as the NOWPAP partners. Provisional table of contents of the feasibility study report is attached in Annex 3. CEARAC will hire a consultant to prepare the draft to complete this task.

4. Expected outcomes

Development of the seagrass database in the NOWPAP region will help mapping seagrass distribution with satellite images in the future. A feasibility study report to be published includes future actions to be taken for assessment of seagrass distribution, and it enables for CEARAC to mobilize a wide range of funding for the assessment. Collected information will also be contributed to Ocean Biogeographic Information System (OBIS) so as to increase information worldwide as well as to be utilized for setting marine protected areas.

5. Schedule

The time line of tasks in this activity is shown as follows.

<table>
<tr><th colspan="2">Time</th><th>Action</th><th>Main body</th></tr>
<tr><td rowspan="3">2016</td><td>April
14th FPM</td><td>14th CEARAC FPM
- Reviewed and approved the workplan</td><td>CEARAC Secretariat and FPs</td></tr>
<tr><td>June 3-5</td><td>- Participated seagrass summit in Japan</td><td>CEARAC Secretariat</td></tr>
<tr><td>Q4</td><td rowspan="2">- Collected and reviewed literatures on segrass distribution and threats
~~- Making a list of satellite data archives in each case study area (cancelled)~~</td><td rowspan="4">National experts and CEARAC</td></tr>
<tr><td rowspan="4">2017</td><td>Q3</td></tr>
<tr><td>Aug 3</td><td>- Organized an international workshop for assessment of the of seagrass distribution in the NOWPAP region</td></tr>
<tr><td>Q3</td><td>- Estimated image analysis cost for implementing assessment
- Evaluating applicability of remote sensing techniques to detect identified threats to seagrass (in progress)</td></tr>
<tr><td>Q3 to Q4</td><td>- Constructing seagrass database
- Preparing/Publishing a feasibility study report</td><td>CEARAC and consultant</td></tr>
</table>

6. Budget

<table>
<tr><th>Task</th><th>Time</th><th>Outcome</th><th>To be completed</th><th>Main body</th><th>Budget (US$)</th></tr>
<tr><td rowspan="4">- Collecting/reviewing literatures on seagrass distribution and changes
~~-Making list of satellite data archives in each case study area~~</td><td rowspan="4">2016 Q4</td><td rowspan="4">- List of literatures on seagrass distribution and changes in the NOWPAP region

~~- List of available satellite images in selected sea areas in the NOWPAP region~~</td><td rowspan="4">2017 Q1 to Q3</td><td>Expert in China</td><td>4,000</td></tr>
<tr><td>Expert in Japan</td><td>4,000</td></tr>
<tr><td>Expert in Korea</td><td>4,000</td></tr>
<tr><td>Expert in Russia</td><td>4,000</td></tr>
<tr><td>- Evaluation of applicability of remote sensing techniques for assessment of threats to seagrass</td><td>2017 Q3</td><td>- List of parameters for assessment of threats to seagrass</td><td>2016 Q3</td><td>CEARAC</td><td>-</td></tr>
<tr><td>- Estimating image analysis cost for assessment</td><td>2017 Q3</td><td>- Estimation of image analysis cost</td><td>2017 Q3</td><td>CEARAC</td><td>4,000</td></tr>
<tr><td>- Organizing International Workshop</td><td>2017 August</td><td>- Proceedings of International Workshop</td><td>2017 August</td><td>National experts and CEARAC</td><td>15,000</td></tr>
<tr><td>Preparing and publishing report</td><td>2017 Q3</td><td>- A feasibility study report including future actions for assessment of seagrass distribution in the NOWPAP region</td><td>2017 Q3-4</td><td>CEARAC</td><td>5,000</td></tr>
<tr><td colspan="5">Total</td><td>40,000</td></tr>
</table>

Annex 1

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper , report, book, etc.)	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in decimal format) for mapping a pin.		Threats of seagrass reported? (Yes or No)	Describe details of those threats if reported.	Are GIS polygon data for mapping available?
										Latitude	Lontitude			
Guo D.; Zhang P.; Zhang X.; Li W.; Zhang X.and Yuan Y.	2010	Preliminary investigation and study on seagrass species of inshore areas in shandong province	Seagrasses are a type of submerged aquatic vegetation which have evolved from terrestrial plants and have become specialized to live in the marine environment. Seagrasses perform a variety of functions within ecosystems, and have both economic and ecological value . Preliminary survey for seagrass species was performed in inshore areas of Shandong province in July 2008 .In the meantime , morpho logical characte ristics of seag rasses distributing in inshore areas of Shandong province were described. Also, status and degeneration causes of seagrass resources in inshore areas of Shandong province were analyzed .Four species of seagrasses including Zostera marina L., Zostera caespitosa Miki , Phyllospadix iwatensis Makino, and Phyllospadix japonicus were found during the present investigation .The results in the present research will provide data for further resources investigation and restoration of injured biotic community of seagrasses.	Paper	Transactions of Oceanology and Limnolog	2	17-21	Zostera marina L., Zostera caespitosa Miki , Phyllospadix iwatensis Makino, and Phyllospadix japonicus	Kenli County of Dongying City;Lidao Bay;Dongchu Island;Shuangdao Bay;H uiquan Bay o f Qing dao City	na	na	Yes	human activites or nat	No
Yang Z.	1979	The geographical diatribution of seagrass	No abstract	Paper	Transactions of Oceanology and Limnolog	2	41-46	Zostera marina Linn., Zostera japonica Asch. et Graebn, Zostera caespitosa Miki, Phyllospadix iwatensis Makino and Phyllospadix japonicus Makino	along the coast area of Shandong provinces, Liaoning Province, and Hebei Province	na	na	No	No	No
Nie M，Li W.，LiY.，Zhang X.，Qin L.	2014	Chinese Journal of Ecology	In order to study the structural characteristics of the epiphytic algal community of eelgrass(Zostera marina) along Shandong Peninsula，we conducted investigations at Zhanqiao，Qingdao，Shuangdao Bay，Weihai，and Moon Lake，Ｒongcheng in March (spring)，June (summer)，September(autumn) and December (winter) 2012． Epiphytic algal communities of eelgrassin different seasons were comparatively analyzed regarding its diversity index and evennessindex using cluster analysis and multi-dimensional scaling analysis (MDS)． In total，17 species were identified，belonging to 3 classes and 14 genera． Among them，there were 4 genera and 5 species of Ｒ hodophyceae，4 genera and 4 species of Phaeophyceae，and 6 genera and 8 species of Chlorophyceae． The greatest number of species (7) was found at Zhanqiao and Shuangdao in spring，and the lowest (1) at Moon Lake in both autumn and winter． The greatest biomass was found in spring，and the lowest in autumn (Zhanqiao)，winter (Shuangdao) and summer (MoonLake)． The Shannon diversity index and Pielou's evenness index were the lowest at Zhanqiao，while the diversity index was the highest at Shuangdao． The species diversity index and evennessindex at the six locations were highest in summer，and lowest in winter． The epiphytic algal community structure varied significantly between at the different locations and at most of the different sampling sites of same locations in different seasons，indicating that seasonal variations and geographical differences played important roles in the variations of community structure．	Paper	Chinese Journal of Ecology	33(7)	1786—1794	Zostera marina L.,	Shuangdao Bay; Jiaozhou Bay;Swan lake	36°03． 5'N，(jiaozhou Bay) 37° 21． 0' N，(Swan Lake) 37°28． 7'N(Shuangdao Bay)，	120°18． 9' E (jiaozhou Bay)122° 34. 0'E(Swan Lake;121°34． 8' E(Shuangdao Bay)	no	no	Yes
Zheng F., Qiu G., Fan H.，Zhang W.	2013	Diversity, distribution and conservation of Chinese seagrass species	Seagrass beds are one of the most productive ecosystems on Earth and an important source of ecosystem services. Accurate mapping of spatial patterns of seagrass species diversity are lacking at the national scale in China, while taxonomic information on Chinese seagrass species requires an urgent update. This lack of information hinders national conservation and restoration programs for seagrass biodiversity. In this article we review studies of diversity, distributions and degradation of seagrass in China. A total of 22 seagrass species distributed along China's coastal regions belong to ten genera and four families, and account for about 30% of known seagrass species worldwide.A check of herbarium material stored in Sun Yat-sen University showed that the seagrass species previously identified as Posidonia australis in Hainan is in factEnhalus acoroides.From our analyses,two Chinese seagrass biotas are proposed. These include the South China Sea Bioregion (SCSBR) and China's Yellow Sea and Bohai Sea Bioregion (CYSBSBR). The SCSBR includes Hainan, Guangxi, Guangdong, Hongkong, Taiwan and Fujian provinces, and contains 15 seagrass species representing nine genera with Halophila ovalis being most widely distributed. The CYSBSBR in-cludes Shandong, Hebei, Tianjin and Liaonin provinces and contains nine seagrass species belonging to three genera with Zostera marina being most widely distributed. The total distribution area for China's seagrass meadows is estimated to be 8,765.1 ha, with Hainan, Guangdong and Guangxi provinces accounting for 64%, 11% and 10% of the area, respectively. Both the number and area of seagrass meadows are much higher in the SCSBR than in the CYSBSBR. In the SCSBR, seagrass meadows are mainly located in the eastern Hai-nan coast, Zhanjiang in Guangdong, Beihai in Guangxi and Dongsha Island in Taiwan, whereas in the CYSBSBR they predominate in Rongcheng in Shandong and Changhai in Liaoning. Halophila ovalis, Thalassia hemprichii and Z. marina are the dominated species in seagrass meadows in Guangdong and Guangxi, Hainan and Taiwan, Shandong and Liaoning respectively. Seagrass degradation in China is mainly attributed to human disturbances caused by fishing, aquaculture and sea reclamation. For conservation purposes we advise the following: (1) initiate an extensive national survey of spatial patterns of seagrass species diversity; (2) conduct long-term monitoring of typical seagrass meadows and establish a national seagrass monitoring network; (3) accelerate legislation for seagrass conservation and include some ecologically-significant seagrass meadows as reserves; (4) invest more finance in research on the restoration of seagrass beds and conservation of seagrass germplasm resources; (5) standardize the Chinese names of seagrassesin China.	Paper	Biodiversity Science	21 (5)	517–526	Zostera marina Linn., Zostera japonica Asch. et Graebn, Zostera caespitosa Miki, Phyllospadix iwatensis Makino and Phyllospadix japonicus Makino	along the coast area of Shandong provinces, Liaoning Province, and Hebei Province and Tianjing	no	no	Yes	human activites such as seafish catch, enclosed as land, sand digging and natural enviromental change, typhoon	Yes
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Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper , report, book, etc.)	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in decimal format) for mapping a pin.		Threats of seagrass reported? (Yes or No)	Describe details of those threats if reported.	Are GIS polygon data for mapping available?
										Latitude	Lontitude			
Zhang X.，.Zhou Y.，Wang F.，Liu P.，Liu B.，Liu X.，Yang H.	2013	Ecological characteristics of Zostera japonica population in Swan Lake of Rongcheng，Shan-dong Province of China	In this study，a large area of well preserved Zostera japonica dominated meadow was found in a coastal lagoon，Swan Lake，in Rongcheng of Shandong Province． Due to its unique geographical position and high biomass，this meadow may act as a typical Z．japonica bed in the coastal area of Shandong．From September，2011 to October，2012，an annual investigation was conducted on the Z． japonica and its habitats in east coast of Swan Lake，and the distribution of the Z． japonica and its habitats ecological characteristics were preliminarily understood．The major ingredients of sediments particles in the Z． japonica bed was sand (81%) and silt (14%)． The C and N contents in the sediments were the highest in winter，and the C/N ratio was the highest in autumn．The shoot density，shoot height，and biomass of the Z． japonica were all significantly correlated with water temperature (P ＜0． 05)． There was an obvious change in the Z． japonica growth among seasons，with the peak biomass obtained in August － September． The C and N contents and C/N in Z． japonica leaves also varied with seasons． The leaf C content was significantly higher in autumn than in spring and summer (P ＜0． 05)，the leaf N content was significantly lower in summer than in spring and autumn (P ＜0．01)，whereas the leaf C/N ratio was significantly higher in summer than in spring (P ＜0． 05)． The annual carbon sequestration by the Z．japonica in the Swan Lake was estimated to be 111．4 g C•m－2．	Paper	Chin． J． Appl． Ecol．	24(7)	2033－2039	Zostera japonica Asch. et Graebn,	The Swan Lake	37°21' N	122°34' E	no	no	Yes
Zhou Y. , Zhang X., Xu S., Song X.,Lin H. , Wang P., Gu R.	2016	New discovery of larger seagrass beds with areas > 50 ha in temperate waters of China: An unusual large seagrass (Zostera japonica) bed in the Yellow River estuary	The dwarf eelgrass Zostera japonica was common in the intertidal zone along the coast of China. Nowadays, larger Z. japonica beds are very rare because of the rapid decline resulting from increasingly severe habitat destruction. However, in this study, a large and continuous Z. japonica bed with an area > 1000 ha was found in the Yellow River estuary of Shandong province. This bed was adjacent to a Spartina alterniflora habitat, forming a unique ecological landscape. The basic biological indicators, including biomass and recruitment of Z. japonica, were obtained during two field investigations in May and August, 2015. This discovery will greatly enrich the seagrass distribution databases of China and provide a unique site for further research on this species.	Paper	Marine Sciences	40(9)	95-97	Zostera japonica Asch. et Graebn	Huanghe River mouth	no	no	no	bo	Yes
Liu B., Zhou Y., Liu X., Liu P., Zhang X.	2013	Ecological characteristics research of Zostera marina L. in Sanggou Bay	The ecological characteristics of Zostera marina L. in Sanggou Bay was studied from August 2010 to September 2011. The results showed that the annual mean shoot height of eelgrass ranged from (16.97±5.99) cm to (87.60±20.68) cm, the mean density was (613±201) ind/m 2 , and the individual biomass was 0.97~5.31 g/ind. The average biomass of eelgrass meadow changed from 594.61 to 3255.03 g/m 2 . The average height and wet weight of the eelgrass changed with water temperature. The water temperature range of the eelgrass habitat was 5.3~25.6℃ with an average temperature of 16.3 ℃. The salinity ranged from 28.9 to 31.3 ppt with an average salinity of 30.6 ppt. The main sediment was gravel sand. The annual average contents of carbon in rhizome, leaf sheath and leaf of eelgrass were 32.68%±1.27%, 33.78%±3.06% and 37.01%±1.86%, respectively. Similarly, the annual average contents of nitrogen were 1.62%±0.63%, 2.79%±0.81%, and 3.10%±0.81 %, respectively, and the annual average contents of phosphorus were 0.28%±0.04%, 0.51%±0.10%, 0.48%±0.07% respectively in rhizome, leaf sheath and leaf of eelgrass.	Paper	marine Sciences	37(1)	42-48	Zostera marina L.	Qi island; Sanggou Bay	37° 02′483″N; 37°02′529″N	122°34′129″E ; 122°3	Yes	monsoon storm tide; typhoon, enclosed as land, sand digging	Yes
Liu H.，Huang X.，Wang Y.，Liang Z.，Gu B.，Su J.	2016	Newly discovered seagrass bed and its ecological characteristics in the coastal area of Caofeidian，Bohai Sea	A field study was conducted in the coastal area of Caofeidian，Bohai Sea in October 2015． A broad seagrass bed covering approximately 10 km2 was discovered in the northwestern area of Longdao Island．It is the largest seagrass bed discovered so far in Bohai Sea and Yellow Sea，China，with Zostera marina as the dominant species． Z．marina on the shoal showed patchy distribution，with coverage of 2.8±1.1% and shoot density ranging between 28.21±6.35－101.33±17.99 shoots•m－2．The number of leaves per plant，canopy height，rhizome length and root length ranged between 2.00±0.00－4.70±0.64，15.20±5.84－62.10±7.34 cm，2.67±1.70－22.20±3.92 cm and 3．67±2．36－8．00±1．90 cm, respectively． The average seagrass biomass was 100.48±47.16 g DW•m－2，and the total biomass was estimated to be 1.0×106 kg (dry weight)．A great diversity of nekton and benthic animals was observed during this survey，including a large quantity of juvenile and young fish and molluscs，as well as adult fish and shellfish species．However，the coverage and shoot density of the seagrass were relatively low，and the number of branches and leaves per plant were also relatively few，which indicated a trend of serious decline in the seagrass bed，possibly attributing to seasonal changes as well as excessive anthropogenic activities．This is the first report on the species identification，distribution and ecological characteristics of seagrass in the Caofeidian area，providing an important basis to initiate further study for protecting the seagrass ecosystem in this region．	Paper	Chinese Journal of Ecology	35(7)	1677－1683	Zostera marina L.,	Caofeidian	39°00' N—39°05' N	118°41'E—118°44' E	yes	seafish catch, oil exploitation, enclosed as land, sand digging	Yes
Gao Y., Fang J., Tang W., Zhang J., Ren L., and Du M.	2013	Seagrass meadow carbon sink and amplification of the carbon sink for eelgrass bed in Sanggou Bay	Seagrass meadows occupy less than 0.2%of the area of the world ' s oceans but are estimated to contribute 10% of the yearly estimated organic carbon burial.Globally,seagrass ecosystems could store as much as 19.9Pg organic carbon.The high carbon storage capacity in seagrass meadows may result from the high primary production of seagrass meadows and their capacity to filter out particles from the water column and store them in soils.Eelgrass,Zostera marinais one of the common seagrass species in the northern hemisphere.Investigation in Sanggou Bay showed that the biomass of eelgrass varied between 313.5and 769.3g DW /m2 from 2011to 2012,with the maximum of 738.1g DW /m2 in summer.Primary production was about 2.0～6.4g DW /m2.d and tissue carbon content was 35.5%in the plant.Stored carbon in the eelgrass meadow from primary production was about 543.5gC /m2.yr.Biomass of algal epiphyte was small,with a wet weight of 21.2g/m2 and contributed 30g C /m2.yr carbon storage.As a Ruditapesp hilippinarumstock enhancement area,the carbon sink contribution from the clam was 63.15g C /m2.yr.In addition,when other carbon source,such as stripped particles was considered,the carbon pool capacity was 1 180g C /m 2.yr and the whole of the bed can reach 290Mg C /yr.	Paper	Progress in Fishery Sciences	34(1)	17-21	Zostera marina L.	Sanggou Bay	no	no	no	no	No
Yang G.	2014	Ecological Characteristics of Seagrass and Trophical Dynamical Analysis of Zostera marina L. in Littoral of Zhangzi Island	In this paper, Zostera marina L. on typical seagrass beds in Zhangzi island ,Dalian city was the research object. .Morphological,experiment ecological and physiological ecological methods were adopted.and community of seagrasses in Zhangzi island were preliminary understood .Ecological characteristics and nutrition dynamic characteristic of Z.marina L. on typical seagrass beds in Zhangzi island were studied. ash contents, caloric values, element contents (carbon, nitrogen and phosphorus) and correlations of the roots, rhizomes and leaves at the different growth stages of eelgrass (Z.marina L.) were determined and analyzed. The main results are summarized as follows： Preliminary survey for seagrass beds was performed on coastal of Zhangzi island from May 2012 to June 2013. Three species of seagrasses were found, and there were Zostera marina L., Zostera caespitosa Miki and Phyllospadix japonicas Makino. By quarterly surveying from May 2012 to June 2013, the average spacing density of eelgrass (Z.marina L.) on typical seagrass beds in Zhangzi island is 298.60±94.35ind/m2. The average height of eelgrass (Z.marina L.) was 39.27±21.20cm. The height of eelgrass (Z.marina L.) in different tidal zone was significant difference. Height of eelgrass(Z.marina L.): upper tidal zone <mid tidal zone <lower tidal zone. The annual average wet weight of eelgrass(Z.marina L.) on seagrass bed was 1562.40±995.28g/m2, and average biomass was 221.66±	Master thesis				Zostera marina L.	Zhangzi island	39°2'N	122°43'E	no	no	no

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Li L., Zheng F., Liu X.， Jin Y.，Han X	2015	Sexual reproductive characteristics of Zostera marina L. in Shuangdao Bay	We studied sexual reproductive characteristics of a population of eelgrass (Zostera marina L．) in Shuangdao Bay, Weihai, China． At population scale, reproductive shoots were first observed in late March or early April． Initial anthesis occurred in early May， and seed release peaked in late June． Senescent reproductive shoots were detached around early July and the fertile season ended in late July． The phenophases of this species were closely correlated with water temperature and 15℃ was required for initial anthesis． At individual scale，the maximum numbers of reproductive branch and rhipidium were recorded in the initial appearance of reproductive shoots，and they were 4.4 and 4.9 per shoot，respectively． The maximum number of spathes pershoot (18.6) and the maximum height of reproductive shoots (96.2 cm) were observed during the initial seed release with a mean abortion rate of 40%． The average mature seed production of eelgrass was 44.8 per shoot． The maximum density of reproductive shoot (64 shoots•m－2) was fot above- and below-ground productivity were all observed in June, and the lowest value in January and February, respectively. Statistics showed that eelgrass grew slowly and was small in winter as a result of low temperature, and the growth accelerated with temperature rising in spring. The water temperature in early summer was optimal for eelgrass growth, and as a result, the biomass and productivity reached the maximum values. While the biomass, shoot density and producti	Paper	Chinese Journal of Ecology	34(10)	2866－2872	Zostera marina L.,	Shuangdao Bay	37°28'44"N	121°57'48"E	no	no	no (only shrimp pond
Liu K.，Liu F.，Wang F.，Sun X.，Wang W.，Ding C., Liang Z.., Ma X.	2013	Analysis of genetic diversity and structure of Zostera marina populations in Shandong Peninsula	In the present study，random amplified polymorphic DNA (RAPD) molecular marker was used to study the population genetic diversity and structure of five Zostera marina L． populations distributed in Shandong Peninsula: Laizhou bay，Xiaoshi Island，Li Island，Chu Island and Huiquan Bay． Based on the obtained results，suggestions for Z． marina population protection and for seaweed meadow restoration in Shandong peninsula were put forward． In the experiment，42 bands were obtained by RAPD markers amplified through 10 selected primers． The percentage of polymorphic bands was 92． 86%． The results showed that the populations in Shandong Peninsula had high genetic diversity and high genetic differentiation． The AMOVA demonstrated that the inter-population component accounted for 99.68% of the total variation，while the intra population component accounted for 0.32%． Mantel tests showed that 5 populations of Z． marina L． had no correlation between genetic distance and geographic distance． The population in Laizhou Bay that shlgrass is monosexual flower and hermaphrodite.There are two female flowers between two male flowers. The numbers of male flowers and female flowers are 13～19 and7～11 ind/reproductive line , respectively .The character in sediment of eelgrass is gravel	Paper	Journal of Shanhai Ocean University	22(3)	334-340	Zostera marina L.	along the coast of Shandong provinceLidao, Xiaoshidao, and Chudao；Laizhou Bay，Huiquan Bay	na	na	na	na	No
Yu H. Ma Y., Zhang Y.	2007	Ecological characteristics of eelgrass (Zostera marina L.) and Its response to environmental changes	Eelgrass (Zostera marina L.) is an important elementary producer in the inshore ecosysytem. Its ecological characteristics and response to environmental changes are reviewed and discussed in this paper as following aspects: (1) adaptation to submerged life, (2)propagation strategy in resource allocation, (3) nutritional salt metabolism, (4)contribution to the inshore ecosystem, (5) the reason of eelgrass decline in population.	Paper	Transactions of Oceanology and Limnology	Suppl.	112-120	Zostera marina L.	na.	na	na	Yes	water transparency decrease; pollution ,disease	No
Guo D.; Zhang P.; Zhang X.; Li W.; Zhang X	2010	Ecological Study on Eelgrass of Inshore Areas in Lidao Town of Rongcheng City	Distribution , biomass, morphology , seed and habitat of eelgrass (Zostera marina L .) were surveyed within the water depth of 2 m of inshore areas in Lidao Town of Rongcheng City (between MataJiao and"Waizhe Dao" of Lidao Bay) in June 2008. Eelgrasses in the survey areas show a patch-shape distribution and area for each patch is between 1.5 and 2.0 m2. Average spacing, density, and biomass of eelgrass are 1650 ind/m2, and 3.75 g/ind, respectively. For root, root length range is 2～14 cm and average root weight, root length, and diameter of root are 0.43 g/ind , 4.83cm , and 0.1 mm , respectively. For rhizome , average rhizome weight , rhizome length and diameter of rhizome are 0.4609 g/ind, 4.407cm/ind and 2.159 mm, respectively. For node , average numbers of node and node length are 9.27nodes/ind and 5.144 mm , respectively .For leaf , leaf length range is 17～70 cm and average leaf weight, leaf width, leaf length and sheath length are 2.294 g/ind, 5.28 cm , 45.23 cm and 6.824 cm , respectively. Flower of eelgrass is monosexual flower and hermaphrodite.There are two female flowers between two male flowers. The numbers of male flowers and female flowers are 13～19 and7～11 ind/reproductive line , respectively .The character in sediment of eelgrass is gravel sand. The results in this paper enrich the knowledge of eelgrass ecology and provide data for study on restoration of injured eelgrass biome .	Paper	perodical of ocean univeristy of China	40(9)	051～055	Zostera marina L.	Lidao town	na	na	Yes	aquaculture and enclo	No
Li Y., Li W., Nie M., Zhang X.	2014	Seasonal variations in the morphology and growth of Zostera marina in Swan Lake, Shandong	The morphological characteristics, density, biomass and productivity of Zostera marina L. in Swan Lake were monitored monthly from August 2012 to July 2013. The results showed that the highest and lowest values of shoot height were observed in July and January, respectively. The highest values of sheath height, sheath and leaf width were all observed in July, and the lowest value of sheath height in January, and the lowest values of sheath and leaf width were all observed in February. The highest values of terminal, lateral and flowering shoot density were observed in June, April and May, respectively, and the lowest values were observed in January, August and July, respectively. The highest values of shoot biomass and above-ground biomass of eelgrass all appeared in July, and the highest value of below-ground biomass appeared in October, while the lowest values of shoot and above-ground biomass all appeared in January, and the lowest value of below-ground biomass appeared in March. The highest values of shoot above- and below-ground productivity were all observed in June, and the lowest value in January and February, respectively. Statistics showed that eelgrass grew slowly and was small in winter as a result of low temperature, and the growth accelerated with temperature rising in spring. The water temperature in early summer was optimal for eelgrass growth, and as a result, the biomass and productivity reached the maximum values. While the biomass, shoot density and productivity of eelgrass began to decrease in late summer and early autumn because of the extremely high water temperature. These seasonal variations were strongly correlated with seasonally varied water temperature.	Paper	Marine Sciences	38(9)	39-46	Zostera marina L.	the Swan Lake	37°20.3'~37°21.6'N	122°33.2'~122°35.0'E	no	no	Yes
Yang Z	1984	The studies on seagrass beds and its epiphytes in the Qingdao coast	Seagrass beds are one of the characteristics of shallow coastal waters in tropical and temperate zones, since seagrasses are green, photosynthesizing organisms occurring as mass vegetation, they must play an important part as primary producers. According to our own survey, the seagraa beds in the Qindao coast area distributed in Jiangezhuang, Shilaoren, Maidao, Zhanshan, Taipingwan, Huiquanwan, Tuandao, Xuejiadao, Huangdao, Zhanggezhuang and Hongshiya. One of them, Jianggezhuang seagrass bed, is a Phyllospadix bed and the other are all Zostera beds. The production of Zostera marina L. is estimated to be 564 gc/m2 each year, while Z ceaspitosa Miki 432 gc/m2 each year, and Phyllospadix iwatensisi Makino 696 gc/m2 each year. In the general sense an epipht is any organism that lives a plant, whether or not a nutritional relationship exists, the present paper deals with flora and fauna epiphytic on both forms of seagrass beds in the Qingdao coast. At the end two appendices area attached where 266 species of slgrass is monosexual flower and h	Paper	Journal of oceanography of Huanghai & Bohai	2(2)	56-67	Zostera marina Linn., Zostera caespitosa Miki, Phyllospadix iwatensis Makino and	Jiangezhuang, Shilaoren, Maidao, Zhanshan, Taipingwan, Huiquanwan, Tuandao, Xuejiadao, Huangdao, Zhanggezhuang and Hongshiya.	na	na	no	no	no

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper, report, book, etc.)	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in decimal format) for mapping a pin.		Threats of seagrass reported? (Yes or No)	Describe details of those threats if reported.	Are GIS polygon data for mapping available?
										Latitude	Lontitude			
Liu K., Liu F., Wang F., Sun X., Wang W., Ding C., Liang Z., Li T.	2012	Survey and identification of Zosteraceae along Shandong Peninsula coast	In order to further investigate the species and distribution of Zosteraceae along the coast of Shandong Peninsula, ecological survey was performed during August~October, 2011. Based on morphological characteristics, ITS sequences were analyzed to identify the Zosteraceae samples.Three species were found during the survey, namely, Zostera marina L, Zostera japonica Ascherson Graebner,and Phyllospadix iwatensis Makino. Among them, Z. marina distributed most widely but in different patterns in each place: mottled in Laizhou Bay, sporadic in Huiquan Bay, and in large stretches along the coast of Lidao, Xiaoshidao and Chudao. Z. japonica was found in less bimass, showing a mottled distribution in Laizhou Bayand a sporadic distribution in Guangrao County. P. iwatensis was found only in Shilaoren Beach in Qingdao with a patchy distribution. The survey also revealed that seagrass beds of Zosteraceae along Shandong Peninsula coast have been damaged and have degenerated in various degrees. Along the coast of Lidao, Xiaoshidao, and Chudao, Zosteraceae distributed in large stretches, while in other surveyed areas it showed a patchy or sporadic distribution. Specifically, seagrass beds of Zosteraceae along Rizhao coast seemed to be completely destroyed,and none Zosteraceae species was found.	Paper	Progress in fishery sciences	33(6)	99-105	Zostera marina L, Zostera japonica Ascherson Graebner,and Phyllospadix iwatensis Makino	Lidao, Xiaoshidao, and Chudao; Laizhou Bay, Huiquan Bay	37.20 (Laizhou Ba)	119.33(Laizhou Ba)	Yes	Land reclamation, coastal overdevelopment	No
Gao Y., Jiang Z. , Fang J., Du M.,Liu Y. , Jiang W., Zou J., Fang J.	2016	Ecological function of seagrass Zostera marina L.bed in sea cucumber pond	In order to determine the ecological function of seagrass Zostera marina L. in sea cucumber culture, water temperature and dissolved oxygen in the eelgrass bed of a sea cucumber pond were determined and compared with the adjacent sandflat. Food sources used by sea cucumber Apostichopus japonicas were determined by comparing their stable isotope signatures (δ 13 C, δ 15 N) with those of food source. Proportions of different carbon sources were estimated using the SIAR mixing model on δ 13 C and δ 15 N values. The results showed that water temperature at eelgrass patch bottom was 0 to 0.33 °C lower than the naked sandflat. Surface and bottom dissolved oxygen showed no differences between low eelgrass coverage (0 to 25%) area and sandflat, while in area with mid-to-high eelgrass coverage, resolved oxygen was 0.12 mg/L~0.62 mg/L higher in surface water. Bottom dissolved oxygen was lower in mid-to-high eelgrass coverage (0 to 0.38 mg/L). Stable isotope signatures δ 13 C and δ 15 N of sea cucumbers A. japonicus waslgrass is monosexual flower and hermaphrodite.There are two female flowers between two male flowers. The numbers of male flowers and female flowers are 13～19 and7～11 ind/reproductive line , respectively .The character in sediment of eelgrass is gravel sand. The results in this paper enrich the knowledge of eelgrass ecology and provide data for study on restoration of injured eelgrass biome .oductivity reached the maximum values. While the biomass, shoot density and productivity of eelgrass began to decrease in late summer and early autumn because of the extremely high water temperature. These seasonal variations were strongly correlated with seasonally varied water temperature.SBR. In the SCSBR, seagrass meadows are mainly located in the eastern Hainan coast, Zhanjiang in Guangdong, Beihai in Guangxi and Dongsha Island in Taiwan, whereas in the CYSBSBR they predominate in Rongcheng in Shandong and Changhai in Liaoning. Halophila ovalis, Thalassia hemprichii and Z. marina are the dominated species in seagrass meadows in Guangdong and Guangxi, Hainan and Taiwan, Shandong and Liaoning respectively. Seagrass degradation in China is mainly attributed to human disturbances caused by fishing, aquaculture and sea reclamation. For co	Paper	Journal of fisheries of china	40(6)	925-932	Zostera marina L.	Ponds in Sanggou	37°02'06"N,	122°32'46"E	no	no	No (only shrimp pond
yang D.	2017	seagrass distribution, ecological structure and carbon sink in China	本书主要着力于海草碳汇的研究方法、通量等方面的研究，是本书作者的第一次出版相关的著作。 本书首先着重讨论海草及碳汇的遥感监测方法， 并对卫星遥感海草的水体校正进行阐述。在中国海草分布方面，可以粗略分为两个大的海域：北部海域和南部海域。北部海域包括山东半岛和辽东半岛；南部海域包括广东、广西和海南。这种分布与温带北太平洋区系和热带印度-太平洋区系相切合。大叶藻、红纤维虾海藻、黑纤维虾海藻主要分布于北部海域，泰来藻、海昌蒲、二药藻、喜盐草等主要分布于南部区域。而日本大叶藻和川蔓藻在南部海域和北部海域均有分布。并对单种海草的分布进行了作图。在海草生态系统结构方面，着重讨论了海南海草床和广西海草床的结构。在此基础上，对海草生态系统中的附生生物、细菌以及浮游植物、浮游动物和底栖生物进行了分别探讨。海草碳汇方面，分别讨论了山东、台湾以及海南海草床的碳汇通量。虽然海草净初级生产力只有500g.C a-1m-2, 但海草床的年埋藏量可以达到14Kg C a-1 m-2，远远高出海草本身的初级生产力。	book	Chinese Sciences Press			Zostera marina Linn., Zostera japonica Asch. et Graebn, Zostera caespitosa Miki, Phyllospadix iwatensis Makino and Phyllospadix japonicus Makino	Swan Lake, etc	37.346	122.572	Yes	human activites or natural enviromental change, typhoon	Yes

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper, report, book, etc.)	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latitude and lontitude in decimal format) for mapping a pin.		Threats of seagrass reported? (Yes or No)	Describe details of those threats if reported.	Are GIS polygon data for mapping available?
										Latitude	Lontitude			
		中国海草的多样性、分布及保护 (Diversity, distribution and conservation of Chinese seagrass species)	Abstract: Seagrass beds are one of the most productive ecosystems on Earth and an important source of ecosystem services. Accurate mapping of spatial patterns of seagrass species diversity are lacking at the national scale in China, while taxonomic information on Chinese seagrass species requires an urgent update. This lack of information hinders national conservation and restoration programs for seagrass biodiversity. In this article we review studies of diversity, distributions and degradation of seagrass in China. A total of 22 seagrass species distributed along China's coastal regions belong to ten genera and four families, and account for about 30% of known seagrass species worldwide. A check of herbarium material stored in Sun Yat-sen University showed that the seagrass species previously identified as Posidonia australis in Hainan is in fact Enhalus acoroides. From our analyses, two Chinese seagrass biotas are proposed. These include the South China Sea Bioregion (SCSBR) and China's Yellow Sea and Bohai Sea Bioregion (CYSBSBR). The SCSBR includes Hainan, Guangxi, Guangdong, Hongkong, Taiwan and Fujian provinces, and contains 15 seagrass species representing nine genera with Halophila ovalis being most widely distributed. The CYSBSBR includes Shandong, Hebei, Tianjin and Liaonin provinces and contains nine seagrass species belonging to three genera with Zostera marina being most widely distributed. The total distribution area for China's seagrass meadows is estimated to be 8,765.1 ha, with Hainan, Guangdong and Guangxi provinces accounting for 64%, 11% and 10% of the area, respectively. Both the number and area of seagrass meadows are much higher in the SCSBR than in the CYSBSBR. In the SCSBR, seagrass meadows are mainly located in the eastern Hainan coast, Zhanjiang in Guangdong, Beihai in Guangxi and Dongsha Island in Taiwan, whereas in the CYSBSBR they predominate in Rongcheng in Shandong and Changhai in Liaoning. Halophila ovalis, Thalassia hemprichii and Z. marina are the dominated species in seagrass meadows in Guangdong and Guangxi, Hainan and Taiwan, Shandong and Liaoning respectively. Seagrass degradation in China is mainly attributed to human disturbances caused by fishing, aquaculture and sea reclamation. For conservation purposes we advise the following: (1) initiate an extensive national survey of spatial patterns of seagrass species diversity; (2) conduct long-term monitoring of typical seagrass meadows and establish a national seagrass monitoring network; (3) accelerate legislation for seagrass conservation and include some ecologically-significant seagrass meadows as reserves; (4) invest more finance in research on the restoration of seagrass beds and conservation of seagrass germplasm resources; (5) standardize the Chinese names of seagrassesin China.	Paper	Biodiversity Science	21(5)	517-526	Please fill in	Entire Chinesecoa	#N/A	#N/A	Please fill in	Please fill in	No
Kun-Seop Lee, Sang Rul Park, Jung-Bae Kim	2005	Production dynamics of the eelgrass, Zostera marina in two bay systems on the south coast of the Korean peninsula	Production dynamics of eelgrass, Zostera marina was examined in two bay systems (Koje Bay and Kosung Bay) on the south coast of the Korean peninsula, where few seagrass studies have been conducted. Dramatically reduced eelgrass biomass and growth have been observed during summer period on the coast of Korea, and we hypothesized that the summer growth reduction is due to increased water temperature and/or reduced light and nutrient availabilities. Shoot density, biomass, morphological characteristics, leaf productivities, and tissue nutrient content of eelgrass were measured monthly from June 2001 to April 2003. Water column and sediment nutrient concentrations were also measured monthly, and water temperature and underwater irradiance were monitored continuously at seagrass canopy level. Eelgrass shoot density, biomass, and leaf productivities exhibited clear seasonal variations, which were strongly correlated with water temperature. Optimal water temperature for eelgrass growth in the present study sites was about 15–20°C during spring period, and eelgrass growths were inhibited at the water temperature above 20°C during summer. Daily maximum underwater photon flux density in the study sites was usually much higher than the light saturation point of Z. marina previously reported. Densities of each terminal, lateral, and reproductive shoot showed their unique seasonal peak. Seasonal trends of shoot densities suggest that new eelgrass shoots were created through formation of lateral shoots during spring and a part of the vegetative shoots was transformed into flowering shoots from March. Senescent reproductive shoots were detached around June, and contributed to reductions of shoot density and biomass during summer period. Ambient nutrient level appeared to provide an adequate reserve of nutrient for eelgrass growth throughout the experimental period. The relationships between eelgrass growth and water temperature suggested that rapid reductions of eelgrass biomass and growth during summer period on the south coast of the Korean peninsula were caused by high temperature inhibition effects on eelgrass growth during this season.	paper	Marine Biology	147	1091-1108	Zostera marina	Kosung Bay, Koje Bay	N34.948531	E128.324208	No		No
Sang Yong Lee, Jeong Bae Kim, Sung Mi Lee	2006	Temporal dynamics of subtidal Zostera marina and intertidal Zostera japonica on the southern coast of Korea	The temporal dynamics of two seagrass species, Zostera marina and Z. japonica, were monitored monthly in Dadae Bay, Geoje Island, on the southern coast of Korea. Plant morphological characteristics, shoot density, biomass, leaf production, reproductive effort, and environmental characteristics were monitored from July 2001 to July 2002. Zostera japonica occurred in the intertidal zone and Z. marina occurred in the subtidal zone from 0.5 to 2.5 m below the mean low water level. Shoots and rhizomes were significantly larger in Z. marina than in Z. japonica, whereas the shoot density was greater in Z. japonica than in Z. marina. Despite differences in morphology and shoot density, biomass did not differ significantly between the species. Reproduction occurred from April to June in Z. marina and from May to July in Z. japonica. The proportion of reproductive shoots was approximately three times higher in Z. marina than in Z. japonica. Seasonal variation in the biomass of Z. japonica was caused by changes in both shoot size and density, whereas that of Z. marina was mainly caused by changes in shoot length. Leaf production in Z. marina and Z. japonica showed clear seasonal variation, and leaf production in Z. marina (2.6 ± 0.2 g DW·m−2·day−1) was higher than that in Z. japonica (1.7 ± 0.2 g DW·m−2·day−1). The mean plastochrone interval was not significantly different between the two species, whereas the leaf lifetime of Z. marina was longer (69 ± 7.8 days) than that of Z. japonica (59 ± 8.3 days). Our results indicated that seasonal leaf growth patterns in Z. japonica are correlated with irradiance and temperature, whereas those in Z. marina respond most to irradiance. Seasonal changes in irradiance appeared to control the temporal variation in above-ground biomass in both species.	paper	Marine Ecology	27	133-144	Zostera marina, Zoster japonica	Koje Island	N34.732419	E128.625469	No		Yes
Donhyug Kang, Sungho Cho, Hyoungsul La, Jong-Man Kim, Jungyul Na, Jung-Goo Myoung	2006	Estimating Spatial and Vertical Distribution of Seagrass Habitats Using Hydroacoustic System	Seagrass meadows are considered as critical habitats for a wide variety of marine organisms in coastal and estuarine ecosystems. In many cases, studies on the spatial/temporal distribution of seagrass have depended on direct observations using SCUBA diving. As an alternative method fur studying seagrass distribution, an application of hydroacoustic technique has been assessed for mapping seagrass distribution in Dongdae Bay, on the south coast of Korea, in September 2005. Data were collected using high frequency transducer (420 kHz split-beam), which was installed with towed body system. The system was linked to DGPS to make goo-referenced data. Additionally, in situ seagrass distribution has been observed using underwater cameras and SCUBA diving at four stations in order to compare with acoustic data. Acoustic survey was conducted along 23 transects with 3-4 blot ship speed. Seagrass beds were vertically limited to depths less than 3.5m and seagrass height ranged between 55 and 90cm at the study sites. Dense seagmss beds were mainly found at the entrance of the bay and at a flat area around the center of the bay. Although the study area was a relatively small, the vertical and spatial distributions of the seagrass were highly variable with bathymetry and region. Considering dominant species, Zostera marina L., preliminary estimation of seagrass biomass with acoustic and direct sampling data was approximately , and total biomass of 104 tones (coefficient variation: 25.77%) was estimated at the study area. Hydroacoustic method provided valuable information to understand distribution pattern and to estimate seagrass biomass.	Paper (in korean and English abstract)	Ocean and Polar Research	28(3)	225-236	Zostera marina	Changseon-do	N34.889544	E128.021744	No		Yes

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper , report, book, etc.)	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in decimal format) for mapping a pin.		Threats of seagrass reported? (Yes or No)	Describe details of those threats if reported.	Are GIS polygon data for mapping available?
										Latitude	Lontitude			
Liu K., Liu F., Wang F., Sun X., Wang W., Ding C., Liang Z., Li T.	2012	Survey and identification of Zosteraceae along Shandong Peninsula coast	In order to further investigate the species and distribution of Zosteraceae along the coast of Shandong Peninsula, ecological survey was performed during August~October, 2011. Based on morphological characteristics, ITS sequences were analyzed to identify the Zosteraceae samples.Three species were found during the survey, namely, Zostera marina L, Zostera japonica Ascherson Graebner,and Phyllospadix iwatensis Makino. Among them, Z. marina distributed most widely but in different patterns in each place: mottled in Laizhou Bay, sporadic in Huiquan Bay, and in large stretches along the coast of Lidao, Xiaoshidao and Chudao. Z. japonica was found in less bimass, showing a mottled distribution in Laizhou Bayand a sporadic distribution in Guangrao County. P. iwatensis was found only in Shilaoren Beach in Qingdao with a patchy distribution. The survey also revealed that seagrass beds of Zosteraceae along Shandong Peninsula coast have been damaged and have degenerated in various degrees. Along the coast of Lidao, Xiaoshidao, and Chudao, Zosteraceae distributed in large stretches, while in other surveyed areas it showed a patchy or sporadic distribution. Specifically, seagrass beds of Zosteraceae along Rizhao coast seemed to be completely destroyed,and none Zosteraceae species was found.	Paper	Progress in fishery sciences	33(6)	99-105	Zostera marina L, Zostera japonica Ascherson Graebner,and Phyllospadix iwatensis Makino	Lidao, Xiaoshidao, and Chudao；Laizhou Bay，Huiquan Bay	37.20 (Laizhou Ba)	119.33(Laizhou Ba)	Yes	Land reclamation, coastal overdevelopment	No
Gao Y., Jiang Z. , Fang J., Du M.,Liu Y. , Jiang W., Zou J., Fang J.	2016	Ecological function of seagrass Zostera marina L.bed in sea cucumber pond	In order to determine the ecological function of seagrass Zostera marina L. in sea cucumber culture, water temperature and dissolved oxygen in the eelgrass bed of a sea cucumber pond were determined and compared with the adjacent sandflat. Food sources used by sea cucumber Apostichopus japonicas were determined by comparing their stable isotope signatures (δ 13 C, δ 15 N) with those of food source. Proportions of different carbon sources were estimated using the SIAR mixing model on δ 13 C and δ 15 N values. The results showed that water temperature at eelgrass patch bottom was 0 to 0.33 °C lower than the naked sandflat. Surface and bottom dissolved oxygen showed no differences between low eelgrass coverage (0 to 25%) area and sandflat, while in area with mid-to-high eelgrass coverage, resolved oxygen was 0.12 mg/L~0.62 mg/L higher in surface water. Bottom dissolved oxygen was lower in mid-to-high eelgrass coverage (0 to 0.38 mg/L). Stable isotope signatures δ 13 C and δ 15 N of sea cucumbers A. japonicus was subtidal zones of 2 m MSL (mean sea level) depth, and Z. caulescence was found in subtidal zones of 2.5-5 m MSL. or sporadic distribution. Specifically, seagrass beds of Zosteraceae along Rizhao coast seemed to be completely destroyed,and none Zosteraceae species was found.idal zones at a 2 m mean sea level (MSL) depth. The leaf productivity of Zostera marina was . The annual production of eelgrass was , which corresponds to . The total production of eelgrass was , which corresponds to a beds in the Nakdong River estuary. This high C and N incorporation into Z. marina tissues suggests that existing Z. marina meadows play important roles in C and N cycles in this estuary. Although the currently existing Z. marina beds in this estuary are persisting and play an important ecological role, anthropogenic factors that cause seagrass declines still affect the estuary. Thus, effective management and monitoring of Z. marina beds and environmental factors are critical to protecting and conserving this invaluable component of the Nakdong River estuary.sed by high temperature inhibition effects on eelgrass growth during this season.의 유전적 다양 성이 가장 높고, 가막만 생육지가 가장 낮은 것으로 나타났다. Analysis molecular variance (AMOVA) 분석 결과는 유전적 변이의 대부분인 76%가	Paper	Journal of fisheries of china	40(6)	925-932	Zostera marina L.	Ponds in Sanggou	37°02'06"N，	122°32'46"E	no	no	No (only shrimp pond
yang D.	2017	seagrass distribution, ecological structure and carbon sink in China	本书主要着力于海草碳汇的研究方法、通量等方面的研究，是本书作者的第一次出版相关的著作。 本书首先着重讨论海草及碳汇的遥感监测方法， 并对卫星遥感海草的水体校正进行阐述。在中国海草分布方面，可以粗略分为两个大的海域：北部海域和南部海域。北部海域包括山东半岛和辽东半岛；南部海域包括广东、广西和海南。这种分布与温带北太平洋区系和热带印度-太平洋区系相切合。大叶藻、红纤维虾海藻、黑纤维虾海藻主要分布于北部海域，泰来藻、海昌蒲、二药藻、喜盐草等主要分布于南部区域。而日本大叶藻和川蔓藻在南部海域和北部海域均有分布。并对单种海草的分布进行了作图。在海草生态系统结构方面，着重讨论了海南海草床和广西海草床的结构。在此基础上，对海草生态系统中的附生生物、细菌以及浮游植物、浮游动物和底栖生物进行了分别探讨。海草碳汇方面，分别讨论了山东、台湾以及海南海草床的碳汇通量。虽然海草净初级生产力只有500g.C a-1m-2, 但海草床的年埋藏量可以达到14Kg C a-1 m-2，远远高出海草本身的初级生产力。	book	Chinese Sciences Press			Zostera marina Linn., Zostera japonica Asch. et Graebn, Zostera caespitosa Miki, Phyllospadix iwatensis Makino and Phyllospadix japonicus Makino	Swan Lake, etc	37.346	122.572	Yes	human activites or natural enviromental change, typhoon	Yes
Keunyong Kim, Ju-hyoung Kim, Kwang Young Kim	2008	Using a Digital Echosounder to Estimate Eelgrass (Zostera marina L.) Cover and Biomass in Kwangyang Bay	Eelgrass beds are very productive and provide nursery functions for a variety of fish and shellfish species. Management for the conservation of eelgrass beds along the Korean coasts is critical, and requires comprehensive strategies such as vegetation mapping. We suggest a mapping method to spatial distribution and quantify of eelgrass beds using a digital echosounder. Echosounding data were collected from the northeast part of Kwangyang Bay, on the south of Korea, in March, 2007. A transducer was attached to a boat equipped with a DGPS. The boat completed a transect survey scanning whole eelgrass beds of 11.7 km2 with a speed of 1.5-2 m s-1 (3-4 knot). The acoustic reflectivity of eelgrass allowed for detection and explicit measurements of canopy cover and height. The results showed that eelgrass bed was distributed in depth from 1.19 to 3.6 m (below MSL) and total dry weight biomass of 4.1 ton with a vegetation area of 4.05 km2. This technique was found to be an effective way to undertake the patch size and biomass of eelgrass over large areas as nondestructive sampling.	Paper (in korean and English abstract)	Algae	23(1)	83-90	Zostera marina	Namhae Is.	N34.929631	E127.856422	Yes	Land reclamation, Construction	Yes

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper, report, book, etc.)	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in decimal format) for mapping a pin.		Threats of seagrass reported? (Yes or No)	Describe details of those threats if reported.	Are GIS polygon data for mapping available?
										Latitude	Lontitude			
Jeong Bae Kim, Jung-Im Park, Kun-Seop Lee	2009	Seagrass distribution in Deuryang Bay	Seagrass meadows are important biogenic habitats for a wide variety of marine animals and plants, a source of organic carbon for commercially important animals, and act as a nutrient filter in estuarine and coastal ecosystems. As such, mapping the distribution of seagrass beds provides us with an important component of management and conservation strategies. To survey seagrass distribution within Deukryang Bay, we directly observed seagrass beds using SCUBA in Boseong-gun, Goheung-gun, and Jangheung-gun. Seagrass distribution in Geogeum and Gumdang islands were not observed. Specifically, we monitored the distribution area, species composition, morphology, density, and biomass of seagrass meadows. Seagrass beds were mapped for Daikum-ri coast, Deukryang island, Yongjeong-ri coast, Samsan-ri coast and Ongam-ri coast. Total seagrass coverage in Deukryang Bay was , of which was Zostera marina, Z. caulescence and Z. japonica. Z. japonica was found in intertidal zones, Z. marina was found from the intertidal to subtidal zones of 2 m MSL (mean sea level) depth, and Z. caulescence was found in subtidal zones of 2.5-5 m MSL.	paper (in korean and English abstract)	The Korean Society of Fisheries and Aquatic Science	42(5)	509-517	Zostera marina, Zoster japonica, Zoster caulescens	1. Goheung 2. Jangheung	1. N34.596564 2. N34.436806	1. E127.156292 2. E126.906517	Yes	Land reclamation	Yes
Sang Rul Park, Jong-Hyeob Kim, Chang-Keun Kang, Soonmo An, Ik Kyo Chung, Jeong Ha Kim, Kun-Seop Lee	2009	Current status and ecological roles of Zostera marina after recovery from large-scale reclamation in the Nakdong River estuary, Korea	Large Zostera marina meadows (covering 13.6 km2) existed in the Nakdong River estuary on the south coast of Korea until the mid-1980s, but these Z. marina beds nearly disappeared due to reclamation of adjacent mud flats for the construction of a port and industrial complex during the late 1980s. Partial recovery of Z. marina meadows occurred recently, and Z. marina coverage of about 0.3 km2 was observed in this estuary. In this study, shoot morphology, density, biomass, productivity, and tissue nutrient content were measured to evaluate the current status of the Z. marina meadows by comparing these data to those for persistent seagrass meadows in similar geographical areas. Additionally, we examined the ecological roles of Z. marina in this estuary after recovery from the large-scale disturbance. Shoot density (151 shoots m−2) and total biomass (141 g DW m−2) in the estuary were similar to those reported from other Z. marina meadows in Korea. Annual leaf production (1726 g DW m−2 y−1) was higher than generally observed for Z. marina in other geographical areas. These results imply that the existing Z. marina meadows in this estuary have adjusted to local environmental conditions that changed after large-scale reclamation. Estimated annual whole plant carbon (C) and nitrogen (N) incorporations based on shoot production and tissue C and N content were 810.0 g C m−2 y−1 and 59.7 g N m−2 y−1, respectively. These values were equivalent to 2.4 × 105 kg C y−1 and 1.8 × 104 kg N y−1 for all Z. marina beds in the Nakdong River estuary. This high C and N incorporation into Z. marina tissues suggests that existing Z. marina meadows play important roles in C and N cycles in this estuary. Although the currently existing Z. marina beds in this estuary are persisting and play an important ecological role, anthropogenic factors that cause seagrass declines still affect the estuary. Thus, effective management and monitoring of Z. marina beds and environmental factors are critical to protecting and conserving this invaluable component of the Nakdong River estuary.	paper	Estuarine, Coastal and Shelf Science	81	38-48	Zostera marina	Nakdong River estuary	N35.071747	E128.80655	Yes	Land reclamation	Yes
Jeong Bae Kim, Jung-Im Park, Woo-Jeung Choi, Jae Seong Lee, Kun-Seop Lee	2010	Spatial Distribution and Ecological Characteristics of Zostera marina and Zostera japonica in the Seomjin Estuary	Among common estuarine submerged plants, seagrasses are the most extensively studied due to their ecological importance in estuarine ecosystems. Seagrass meadows are important biological habitats for a wide variety of marine animals and plants. They are a source of organic carbon for commercially important animals. Furthermore, seagrasses act as nutrient filters in estuarine and coastal marine ecosystems. As such, mapping the distribution of seagrass beds is important for management and conservation strategies. In order to survey the seagrass distribution within the Seomjin Estuary, We directly observed seagrass beds in Kwangyang and Hadong using SCUBA. The distribution area, species composition, morphology, density, biomass and productivity of seagrass meadows were examined. Seagrass meadows were distributed in the intertidal and subtidal zones of the Galsa tidal flats, and in the subtidal zone of the neighboring POSCO area. Patches of Zostera japonica was found at patches at the Galsa tidal flats intermediate point. The total estimated seagrass distribution area of the Seomjin Estuary was . Of the total, was Zostera marina (eelgrass) and was Zostera japonica (dwarf eelgrass). Zostera japonica was found in intertidal zones. Zostera marina was found from the intertidal to subtidal zones at a 2 m mean sea level (MSL) depth. The leaf productivity of Zostera marina was . The annual production of eelgrass was , which corresponds to . The total production of eelgrass was , which corresponds to	Paper (in korean and English abstract)	The Korean Society of Fisheries and Aquatic Science	43(4)	351-361	Zostera marina, Zostera japonica	Semjin river estuary	N34.909547	E127.7913	No		Yes
Young Kyun Kim	2012	Genetic structure and genetic information for habitat restoration of seagrasses in the shallow coastal waters of Korea	잘피는 생산성이 높은 수생현화식물로서 경제성이 높고 생태학적으로 중요한 어족자원의 먹이원 및 서식처를 제공한다. 잘피를 직접적인 먹이원으로 활용하는 초식동물은 거의 없으나, 잘피에 의해 생성된 탄소는 연안 및 하구의 food chain에 공급된다. 잘피의 잎은 부착조류의 기질 역할을 하며, 이 들 부착조류는 많은 동물들의 먹이원이 된다. 잘피는 생산성이 높기 때문에 많 은 영양분을 필요로 하며, 잎과 뿌리조직으로부터 해양의 무기영양분을 빠르게 흡수 제거할 수 있다. 잘피는 또한 저질을 안정화시키며, 해류와 파도의 속도를 감소시켜 해양환경의 안정화에 기여한다. 또한 광합성을 통해 만들어진 산소는 저질에 공급되어 호기성 박테리아의 대사에 활용되며, 황화합물을 산화시켜 비 독성 환경을 유지하는 역할을 한다. 따라서 잘피는 연안 및 하구의 생물 종 다 양성을 높이고 수질을 개선하는 중요한 일차생산자이다. 거머리말 (Zostera marina)은 우리 연안에 가장 많고 널리 분포하는 잘 피 종이다. 해호말 (Halophila nipponica)는 2007년 우리 연안에 처음 발견되었으 며, 이후 남해안의 여러 도서지역에서 그 분포가 확인되고 있다. 해호말의 성장 패턴이 열대성 잘피 종과 매우 유사하기 때문에, 해호말은 온대에 적응된 열대 성 잘피 종이라 할 수 있다. 따라서 우리 연안에 가장 많이 분포하고 있는 거머 리말 (Z. marina)과 유입 잘피 종인 해호말 (Halophila nipponica)은 잘피 연구에 있어서 중요한 종이라 할 수 있다. 잘피가 연안 및 하구 생태계에서 중요한 자 원이지만 전세계적으로 자연적인 교란 및 인위적인 교란으로 인하여 잘피생육 지는 그게 감소하고 있다. 우리나라 역시 1970년대 이후 인위적인 교란으로 인 해 잘피생육지가 크게 감소되었다. 잘피생육지의 감소는 유전적 다양성을 감소 시킬 수 있으며, 이는 결과적으로 변화하는 환경에 대한 잠재적인 생존 및 적응 력을 크게 감소시킬 수 있다. 본 학위 논문의 연구 목적은 (1) 우리나라의 남해 연안으로 유입된 해호말의 유입경로를 추론하고 이와 형태학적으로 유사한 종 들이 포함된 H. ovalis species complex 종들과의 유전적 관계를 규명하고, (2) 교 란의 정도에 따른 거머리말 개체군간의 유전적 다양성을 비교하는 것이다. (3) 그리고 거머리말 개체군의 생활사가 유전적 요인에 의해 결정되는지 또는 환경 적 요인에 의해 결정되는지를 조사하였으며, (4) 이식된 거머리말 개체군의 유 전적 구조가 인근의 자연 개체군 및 공여 개체군과 비교했을 때 어떠한 변화가 있는지를 조사하는 것이다. 우리나라 남해연안에 분포하는 Halophila 종은 형태학적 특성에 따라 Halophila nipponica로 동정되었다. 일본의 온대지역에서 처음 발견된 해호말은 형태학적 유사성으로 인하여 H. ovalis로 기록되었다. 본 연구에서 우리연안에 분포하는 해호말이 쓰시마해류나 쿠로시오 해류를 통해 유입되었을 것이라는 가설을 세웠다. Nuclear ribosomal DNA (nrDNA)의 internal transcribed spacer (ITS)는 종간의 진화적 관계나 종내의 지리적 분포의 경향을 밝히는데 주로 이 용되어 왔으며 본 연구에서도 해호말의 유입경로를 파악 및 계통분류학적 유연 관계를 규명하는데 이용하였다. 우리 연안에 분포하는 해호말과 일본의 온대지 역에 분포하는 해호말의 ITS 염기서열 결과는 차이가 없거나 매우 낮았다. 계통 분류학적 분석에서 해호말은 H. okinawensis 및 H. gaudichaudii와 낮은 염기서열 의 차이를 보였으며 하나의 그룹을 형성하였다. 따라서 이들 종을 유사종으로 판단한다면, 일본과 우리 연안에 분포하는 해호말은 쓰시마	Ph.D. dissertation	Busan National University, Korea		30	Halophila nipponica	1. An-do Is. 2. Sorok Is. 3. Namhae Is. 4. Koje Is. 5. Geomun Is.	1. N34.48 2. N34.516944 3. N34.7275 4. N34.963056 5. N34.055833	1. E128.809722 2. E127.136944 3. E128.036389 4. E128.621944 5. E127.282778	No		No

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in		Threats of seagrass reported? (Yes or No)	Describe details of those threats if	Are GIS polygon data for mapping
										Latitude	Lontitude			
Jung-Im Park, Jae-Yeong Park, Min Ho Son	2012	Seagrass distribution in Jeju and Chuja Island	To survey the seagrass distribution in Jeju and Chuja Islands, we directly observedseagrass beds using SCUBA in July, 2011. Distributional area, species composition, morphology,density, and biomass of seagrasses and environmental characteristics were examined in investigationsites. In particular, three protected seagrass species (Zostera marina, Z. caulescens and Z. caespitosa)were found in the investigation areas. While the three species were found in Chuja Island,only Z. marina was distributed in Jeju Island. Z. marina was distributed only north-eastern coastof Jeju Island, and the total coverage was 238,572m2. Total seagrass coverage of Chuja Island was23,584m2. In detail, Z. caulescens Z. caespitosa and Z. marina were 21,216, 1,870 and 498m2, respectively.Of these, Z. marina was found from the intertidal to subtidal zones of 5m MSL (mean sealevel) depth. Z. caespitosa and Z. caulescens were found in subtidal zones of 3~4 m and 4~6mMSL depth, respectively.	Paper (in korean and English abstract)	Korean Journal of Environmental Biology	30(4)	339-348	Zostera marina, Zostera caulescens, Zostera caespitosa	1. Jeju Is. 2. Chuja Is.	1. N33.955203 2. N33.4786	1. E126.331383 2. E126.921719	No		Yes
Jong-Hyeob Kim, Sang Hoon Park, Young Kyun Kim, Seung Hyeon Kim, Jung-Im Park, and Kun-Seop Lee	2014	Seasonal Growth Dynamics of the Seagrass Zostera caulescens on the Eastern Coast of Korea	Zostera caulescens is an endemic seagrass species in Northeastern Asia. Estimated distributional area of this species is approximately 1–5 km2 on the coasts of Korea. Because Z. caulescens has a very limited distribution, the growth dynamics of Z. caulescens is little known in the coastal waters of Korea. In the present study, we investigated the growth dynamics of Z. caulescens in relation to coincident measurements of environmental factors, such as underwater irradiance, water temperature, and nutrient availability. The study was conducted on a monotypic meadow of Z. caulescens in Uljin on the eastern coast of Korea from September 2011 to September 2012. Shoot density and biomass of Z. caulescens showed distinct seasonal variations, and exhibited strong correlations with water temperature suggesting that the seasonal growth of this species was regulated by water temperature. Shoot density and biomass rapidly decreased during the high water temperature period in summer, and thus Z. caulescens is considered a cold water adapted species like other temperate seagrass species on coasts of Korea. Biomass of photosynthetic leaf tissues on reproductive shoots was approximately 4 times higher than that on vegetative shoots. The height of reproductive shoots ranged from 1.2 m in February 2012 to 3.2 m in August 2012, whereas the height of vegetative shoots was usually less than 1.0 m. Leaf tissues on reproductive shoots probably received much more light for photosynthesis than those on vegetative shoots. Thus, reproductive shoots may play an important role in total production of Z. caulescens.	paper	Ocean Science Journal	49(4)	391-402	Zostera caulescens, Zostera marina, Zostera asiatica	Uljin	N37.054825	E129.417992	No		No
Hyeong-Seok Ji, Hee-Jeong Seo, Myeong-Won Kim, Moon Ock Lee, Jongkyu Kim	2014	Marine Environmental Characteristics of Seagrass Habitat in Seomjin River Estuary	This study considered a seagrass habitat in order to analyze the characteristics of a marine environment of seagrass located in the Seomjin river estuary, through an analysis of the distribution of the water depth, field observation, and three-dimensional numerical experiments using an EFDC model. The seagrass habitat was usually distributed at D.L(-) 0.5~0.0 m, and was hardly seen in the intertidal zone higher than that range. The distribution of the water temperature was within the range of , and the seagrass was demonstrated to have a strong tolerance to changes in the water temperature. In addition, the salinity distribution was found to be 27.2~31.0 psu, with suspended solids of 32.1 mg/L, which were higher than the previous research results (Huh et al., 1998), implying that there may be a reduction in the amount of deposits caused by the suspended solids. As for the sedimentary facies, they were comprised of 62.7% sand, 19.1% silt, and 18.2% clay, indicating that the arenaceous was superior and the sedimentary facies were similar to that of Dadae Bay. According to a numerical experiment, the maximum tidal current was 75 cm/s, while the tidal residual current was 10 cm/s, confirming that it sufficiently adapted to strong tidal currents. The erosion and deposition are predicted to be less than 1.0 cm/year. Thus, it is judged that the resuspension of sediments due to tidal currents and the changes in sedimentary facies are insignificant.	Paper (in korean and English abstract)	Journal of Ocean Engineering and Technology	28(3)	236-244	Zostera marina	Semjin river estuary	N34.909547	E127.7913	No		Yes
Keunyong Kim, Jong-Kuk Choi, Joo-Hyung Ryu, Hae Jin Jeong, Kitack Lee, Myung Gil Park, Kwang Young Kim	2015	Observation of typhoon-induced seagrass die-off using remote sensing	Satellite remote sensing has been used as an effective tool to monitor and manage seagrass beds, but this tool is not appropriate to use in highly turbid waters along the coast of Korea. In this study, satellite data were used to identify the method for detecting seagrass beds in turbid bay waters and describing temporal changes over the past 24 years. Moreover, we found the cause of seagrass die-off phenomenon by observing the long-term satellite images and evaluating the impact of the typhoon on seagrass beds. All seagrass spectra from different sensors (Landsat TM/ETM+, Aster, Spot-4, and Kompsat-2) have low reflectance in green and high in NIR regions, whereas unvegetated seawater has the opposite spectrum features. A training area in the green band and Mahalanobis Distance Classification algorithm was adopted for classification and mapping of seagrass beds. The error matrix using the in situ reference data for Kompsat-2 image classification was 72.9% accurate. The average area of seagrass beds was 4.6 km2 from May 1990 to January 2012, and it was consistently >4.0 km2. A die-off of seagrass beds was observed in September 2012 after Typhoon Bolaven, Tembin, and Sanba consecutively passed the study site. When Typhoon Sanba passed the study site, it had sustained maximum wind speed (147.6 km h−1) during low tide, unlike the other typhoons. We found that the water column buffer did not have any effect on resistance of seagrass bed to disturbance, which led to greater damage. Additionally, the three sequential typhoons that passed through during the short time probably produced a cumulative effect. These results allow an understanding of past changes, and reveal the sudden and influential changes in seagrass distribution. As seagrass removal might have negative effect on other associated communities, comprehensive monitoring is required to ensure that disturbed seagrass habitats is recovered naturally.	paper	Estuarine, Coastal and Shelf Science	154	111-121	Zostera marina, Zostera caulescens, Halophila nipponica	Jangheung	N34.436806	E126.906517	Yes	Typhoon	Yes
Jong-Hyeob Kim, Seung Hyeon Kim, Young Kyun Kim, Jung-Im Park, Kun-Seop Lee	2016	Growth dynamics of the seagrass Zostera japonica at its upper and lower distributional limits in the intertidal zone	The seagrass Zostera japonica occurs mainly in the intertidal zone and is thus exposed to widely varying environmental conditions affecting its growth and distribution compared to subtidal seagrasses. The growth dynamics of Z. japonica at its upper and lower distributional limits in the intertidal zone were investigated in Koje Bay on the southern coast of Korea to examine the environmental stresses and limiting factors on the growth of intertidal seagrasses. The shoot density and morphology, biomass, and leaf productivity of Z. japonica were measured in relation to coincident measurements of environmental factors at its upper and lower distributional limits and in an intermediate zone of the intertidal area. The mean exposure time to the atmosphere during low tide in the upper intertidal zone was approximately 1.5- and 1.9-fold longer than that in the intermediate and lower intertidal zones, respectively. Shoot density and biomass were significantly higher in the intermediate zone than at the upper and lower distributional limits. Longer emersion leading to a various of environmental stresses appeared to reduce Z. japonica growth in the upper intertidal zone, whereas interspecific competitive interactions related to irradiance seemed to affect Z. japonica growth in the lower intertidal zone. Shoot size, density, biomass, and leaf productivity were lower in the upper than in the lower zone, implying that emersion-associated stresses in the upper zone had a greater detrimental effect on Z. japonica growth than did stresses occurring in the lower zone. The productivity of Z. japonica showed strong positive correlations with air and water temperature, suggesting enhancement of Z. japonica production at higher temperatures. Thus, the predicted increases in air and water temperature associated with global climate change might have positive effects on the growth and extension in distributional range of this species.	paper	Estuarine, Coastal and Shelf Science	175	1-9	Zostera japonica	Koje Island	N34.801542	E128.567911	No		No

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in		Threats of seagrass reported? (Yes or No)	Describe details of those threats if	Are GIS polygon data for mapping
										Latitude	Lontitude			
Paymeeva L.G.	1973 a	Distribution of Zostera communities in Peter the Great Bay	The data on distribution of three species of Zostera in Peter the Great Bay (Amur and Ussuri bays) are given. The largest areas occupied by thickets of Zostera, small areas with high concentrations of Zostera per unit area and the areas free of vegetation have been allocated. The features of the Zostera cover on the ground, thickets intensity and their distribution in depth are decribed.	paper (in Russian)	Известия ТИНРО Izvestia TINRO	87	145-148	Zostera marina Zostera asiatica Zostera japonica	Peschanaya bay	43.203773	131.728668	No		No
									Narva bay	42.99487	131.50645	No		No
									Minonosok bay	42.60942	130.8646	No		No
									Severnaya bay	42.93046	131.40003	No		No
									Boiyarina bay	42.98912	131.74942	No		No
Paymeeva L.G.	1973 b	Characteristics and state of stocks of Zostera in the southwestern portion of Peter the Great Bay from the Boisman bay to Sivuchya bay	The paper presents the results of algological researches carried out in 1971-1973 in the southwestern portion of Peter the Great Bay, including data on distribution and ecology of Zostera, its areas and stocks in this region.	paper (in Russian)	Известия ТИНРО Izvestia TINRO	92	153-157	Zostera marina Zostera asiatica Zostera japonica	Ekspediciibay	42.65813	130.73486	No		No
									Novgorodskaya bay	42.64789	130.88576	No		No
									Kalevala bay	42.52339	130.84492	No		No
									Troicyibay	42.66331	131.10657	No		No
									Reid Pallada bay	42.59439	130.78608	No		No
									Pemzovaya bay	42.54804	130.84377	No		No
									Boysvan bay	42.76438	131.26552	No		No
Paymeeva L.G.	1974 a	Some features of biology of Zostera in Peter the Great Bay	The paper presents the features of the growth of leaves and rhizomes of Zostera in the course of a year. Some features of its vegetative and sexual reproduction.	paper (in Russian)	Studies of fish biology and fisheries oceanography	5	35-45	Zostera marina a	Novgorodskaya bay	42.64789	130.88576	No		No
Paymeeva L.G.	1974 b	Epiphytes of Zostera (The Sea of Japan)	The article provides the data on plant and animal organisms accreting on Zostera marina and Zostera asiatica seasonally. A list of algae accreting on two spicies of Zostera, their occurrence and epiphytes belonging to a particular geographical group are given.	paper (in Russian)	Известия ТИНРО Izvestia TINRO	98	193-201	Zostera marina Zostera asiatica	Peter the Great Gulf	42.78242	131.67788	No		No
									Valentina bay	43.11665	134.3151	No		No
									Innokentya bay	48.60468	140.17745	No		No
Paymeeva L.G.	1979	Distribution and stocks of Zostera in Primorye from Cape Povorotny to Cape Belkin	For the first time, the article presents data on distribution and ecology of two species of Zostera (Zostera marina, Z. asiatica) in northern Primorye from Cape Povorotny to Cape Belkin (The Sea of Japan). The areas and stocks of Zostera, its fishing grounds have been defined.	paper (in Russian)	Studies of fish biology and fisheries oceanography	10	149-154	Zostera marina Zostera asiatica	Olga Bay	43.70586	135.23448	No		No
									Rynda bay	43.02559	131.79605	No		No
									Kitovoe Rebro bay	44.56663	136.19883	No		No
									Golubichnaya bay	44.90114	136.5287	No		No
									Terney bay	45.0361	136.63977	No		No
Paymeeva L.G.	1980	Dynamics of stocks of Zostera in Peter the Great Bay	The article describes the causes of fluctuations of Zostera stocks in Peter the Great Bay: hydrological regime of waters, massive development of generative shoots, increases in space and density of the plant communitites.	paper (in Russian)	The Fisheries research of temperate waters of Pacific Ocean	book	127-130	Zostera marina	Novgorodskaya bay	42.64789	130.88576	No		No
									Ekspediciibay	42.65813	130.73486	No		No
									Kalevala bay	42.52339	130.84492	No		No
									Troicyibay	42.66331	131.10657	No		No
									Narva bay	42.99487	131.50645	No		No
									Severnaya bay	42.93046	131.40003	No		No
									Peschanaya bay	43.203773	131.728668	No		No
Paymeeva L.G.	1981	The production of Zostera (Zostera marina L. and Zostera asiatica Miki) in Peter the Great Bay	In result of the studies of production of two species of Zostera from Apriul to October in 1976-1978, it was found that its production depends on the hydrological features of a year and the plants habitats. The distinctive rule of increasing of the production from spring to summer with maximum values in May-Jule was traced. The productivity of Z. marine reached its maximum values in cold years in shallow areas of shallow bays where the total biomass growth from April to October was 2943 g/m². Open coastal areas are characterized by the highest productivity in warm years: up to 2335 g/m² for Zostera marina and up to 4297 g/m² for Zostera asiatica.	paper (in Russian)	Commercial seaweeds and their utilization	book	68-73	Zostera marina Zostera asiatica	Novgorodskaya bay	42.64789	130.88576	No		No
									Reid Pallada bay	42.59439	130.78608	No		No
Vyshkvartsev D.I., Peshehodko V.M.	1982	Mapping of the dominant species of aquatic vegetation and analysis of their role in the ecosystem of the shallow inlets of Posiet Bay of the Sea of Japan	It was revealed that in the semi-enclosed inlets of Novgorodskaya and Expeditsii and in the upper horizons (up to 7 m) of open sea Reid Pallady Bay the dominant position by the area (98, 48 and 75%) and in total biomass (91, 63 and 41%, respectively) the sea grasses take, including zostera marine. The share of sea grasses accounts for 60, 36 and 13% respectively of the total recorded synthesis of organic matter by primary producers in the course of a year. The organic matter synthesized by sea grasses gradually leaches through detrital pool from dead leaves and becomes an important factor of supporting a high trophic level in semi-closed inlets of Posiet Bay.	paper (in Russian)	Underwater hydrobiological studies	book	120-130	Zostera marina Zostera japonica Phillospadix iwatensis	Novgorodskaya bay	42.64789	130.88576	No		No
									Reid Pallada bay	42.59439	130.78608	No		No
Kafanov A.I., Lysenko V.N.	1988	Biology of the seagrass Zostera marina	A brief literature review. Examined life cycle, distribution, horology, ecological features, abundance, production characteristics and practical value of Zostera – the most important representative of seagrasses in the Northern Hemisphere.	Paper (in Russian)	Biota and communities of the Far-Eastern seas lagoons and bays of Kamchatka and Sakhalin		93-113	Zostera marina	Sea of Japan			No		No
Kharlamenko V.I., Lysenko V.N.	1991	Productional processes and the role of microheterotrophs in Zostera communities	The values of micro-heterotrophs in production and destruction of organic matter in the community of Zostera marina in Vityaz Inlet of the Sea of Japan were estimated. A distinctive feature of the phytoplankton in the Zostera community is in absence of summer peak of production. There are two peaks in density of the disperse bacterioplankton (the spring one – in April and the summer one – in June and July) and one density peak (in June) of the bacterioplankton aggregated on suspended particles. In comparison with open areas in thickets, the composition of phytoplankton is changing and its annual production is reducing by a third. The bulk of the phytoplankton production is created in the autumn-winter period, its annual production is 12.5 gC m⁻² year⁻¹. The production of bacterioplankton is 2.64 gC m⁻² year⁻¹, it reaches a maximum in September. The annual production of bacteria and yeast on Zostera leaves is 348 mg C gC⁻¹. Epiphytic microorganisms can consume one-third of the organic matter synthesized by zoster.	Paper (in Russian)	Ecosystem research: coastal communities of Peter the Great bay		6-16	Zostera marina	Vytjaz Bay	42.60064	131.1771	No		No
Kharlamenko V.I., Lysenko V.N.	1991	Primery production and microbial destruction of organic matter by epiphytic organisms in Zostera ecosystem of the Sea of Japan	Based on the year-round research of the primary production and destruction, it was found that diatoms Cocconeis scutellum and red algae Pneophyllum lejolisii are the permanent components of the epiphytic community of Zostera marina seagrass. In sum, they give more than 17% of the total annual production of Zostera and epiphytic algae. In January colonial diatom Navicula grevillei is of great importance (up to 40% of the total primary production). By abundance of epiphytic algae, Kommannia zostericola dominates, which production in February-March exceeds the production of Zostera. The production of micro-heterotrophic forms (bacteria, yeast) makes 8.9% of the production of Zostera. Epiphytic microorganisms can consume up to 35.5% of Zostera production.	Paper (in Russian)	Ecosystem research: coastal communities of Peter the Great bay		17-30	Zostera marina	Vytjaz Bay	42.60064	131.1771	No		No
Galysheva YU.A.	2004	Subtidal macrobenthos communities of Vostok Bay (The Sea of Japan) under conditions of anthropogenic impact	The studies were carried out in May, July and October-November of 2000-2002 in Vostok Bay of the Sea of Japan. The community of Zostera marina is common in the inner part of the bay and in Tikhaya Zavod inlet. The plants biomass in this community makes 2150.0 g/m². The calculated floral ratio showed that the environmental state of Vostok Bay deteriorated. In the 1970's the value of the floral ratio was 2.3-2.7, then at present it reaches 3.3, which allows us to characterize the waters of Vostok Bay as of average level of anthropogenic pollution.	Paper (in Russian)	Russian Journal of Marine Biology	v. 30 № 6	423-431	Zostera marina,	Tikhaya Zavod bay	42.89341	132.72823	No		No

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in		Threats of seagrass reported? (Yes or No)	Describe details of those threats if	Are GIS polygon data for mapping
										Latitude	Lontitude			
Petrov K.M.	2004	Underwater vegetation at the coastal zone of Sakhalin Island. Landscape approach to investigation of coastal zone vegatation	The studies were carried out on the Sea of Japan coast of Southern Sakhalin between the cities of Kholmsk and Nevelsk using large-scale aerial photography and light diving equipment. A nearly continuous belt in the coastal portion of shallow abrasive terrace was formed by Zostera marina seagrass community. Finely dispersed, sandy and often silty sediments are followed with clean serried eelgrass thickets, forming the association of Zostera marina. In the distance from the coast, the areas occupied by outcrops of bedrock are increasing. That is outer rim of eelgrass thickets, presented by community of Zostera marina-Sargassum -Mesoalgosa-encrusting calcareous red algae. The outer seaward portion of the abrasive terrace is occupied by the community of sea grass Phyllospadix iwatensis. The close interdependence of phytobenthos structure with elements of the morphological structure of the underwater landscape was revealed.	Paper (in Russian)	Bulletin of St.Peterburg State University	7, № 2	58-69	Zostera marina, Phyllospadix iwatensis	western coast of south Sakhalin Island	46.99314	142.00891	No		No
Gusarova I.S.	2008	Macrophytobenthos of the northern Amur Bay	Anthropogenic transformation of floral-cenotic complex is observed in the inner Amur Bay (Japan Sea) because of its chronic pollution. In total, 58 algae species are recorded here (Chlorophyta - 10, Phaeophyta - 12, Rhodophyta - 36) and 2 seagrass species (Zostera marina and Zostera japonica) in 1986. Cenotic stucture of vegetation is described for 6 certain parts of the Amur Bay, with the bottom cover description and dominant species biomass assessment. During the last 15 years, the floral diversity became lower by 28 % because of brown and red algae disappearance. Green algae play the most important cenotic role and this taxonomic group prevails by the number of dominant species. At De-Friza Peninsula there are fields of seagrass with the maximum morphometric parameters for this area, namely biomass of Zostera marina reaches 1.2-2.5 kg / m² at a depth of 0.5-4 m. The thickets of Zostera marina are located also from Cape Ugolny to Cape Peschany at depths over 1.5 m with biomass 0,7-2,3 kg / m² and a width of 30-40 m. The thickets of Zostera japonica (at depth 0.5 m) and Zostera marina (at depths 0.5-3.0 m) in width from 50 to 100 m and with biomass ranging from 0.7 to 3.5 kg / m² under 30-70% projective coverage are located in Peschanaya Bay.	Paper (in Russian)	Ecosystem research: coastal communities of Peter the Great Bay	155	88-98	Zostera marina Zostera japonica	Amur bay	43.29377	131.88439	No		No
Zharikov V.V., Preobrazhensky B.V.	2010	Ecosystem transformation and its eventual landscape manifestation in the aquaculture-affected Alekseeva cove (Peter the Great Bay, The Sea of Japan)	Alekseev cove (Popov Island, Peter the Great Bay) undergone the transformation under the influence of activity on breeding aquaculture of sea scallop and mussels, is under scientific surveillance during last 40 years. The most recent, 2008 underwater landscape studies made it possible to compare the results of previous and current studies with the spatial structure of ecosystem. Based on modern technology, the holistic underwater landscape, (bentheme) map was designed with the support of the GPS und underwater digital video profiles, 8 bentheme (seascape) types were distinguished. Spatial comparison of bentheme fields with previously published scheme of biocenoses led to the conclusion of progressing irreversible degeneration of spatial structure of ecosystem of the cove.	Paper (in Russian)	UNDERWATER RESEARCH AND ROBOTICS	2(10)	72-84	Zostera marina	Alekseev Bay	42.98394	131.72417	Yes		Yes
Fedorets Yu.V., Sharova O.A., Kosyanenko A.A., Aksentov K.J., Rakov V.A., Vasilyeva L.E.,	2011	Ecological monitoring of marine biota Alekseeva cove (Peter the Great Bay)	The specific structure of ichthyoplankton and macrobenthos of Alekseev cove has been studied. It is established that the destruction of fishes caviar in the sea at early stages of development is connected basically with factors of wind excitement, temperature and salinity of water. The map of mercury distribution in the surface layer of ground deposits was constructed. The thickets of Zostera marina stretches along the south and south-west shores, and by a broad belt in the inner portion. The maximum biomass of eelgrass reached 1285.1 g / m². The highest diversity of macrobenthos species was observed on sandy and pebbled ground in the zone of eelgrass.	Paper (in Russian)	Proceedings of the Samara Scientific Center of the Russian Academy of Sciences	V. 13 № 1(6)	1386-1392	Zostera marina	Alekseev Bay	42.98394	131.72417	No		No
Dulenin A.A.	2012	Resources and distribution of commercial macrophytes in the western Tartar Strait (Khabarovsk Territory)	Diving surveys (1148 diving stations) were conducted at the western coast of the Tartar Strait (the coast of Khabarovsk Territory) in the area of 600 km long and the depth range from 1 to 20-26 m in 2008-2011, and new data on resources and distribution of commercial seaweeds and sea grasses were obtained. The total stock of commercial macrophytes is estimated as 259,000 t. It consists of seaweeds and sea grasses Zostera asiatica, Z. marina, Phyllospadix iwatensis, and Stephanocystis crassipes. Z. asiatica forms belts and fields on sandy and sludge grounds along opened and semiclosed shores, and Z. marina forms fields on sludge grounds in closed bays and harbors. Zostera asiatica is the most representative seagrass species of the area. Monodominant populations of Asian eelgrass in bays and inlets begin from depths 0.5-2.0 m and in the open coast from 7-8 meters and extend to depths of 10-15 m. Biomass in the thickets makes up to 6 kg/m², the total biomass is defined at the level of about 50,000 tons on the area of about 1,700 hectares. Zostera marina forms monodominant settlements in well-protected bays and inlets with biomass 2-4 kg / m². It generates fields 0.3-2.4 km in width, and 0.5-3.0 km in length. The main populations of Zostera marina are located in the bays of Chikhacheva, Sovetskaya Gavan and Falshivaya bay in the vicinity of Sovetskaya Gavan. Large populations of Zostera marina located in Sovetskaya Gavan Bay within the seaport water area, are subject to significant anthropogenic pollution. Common biomass is over 21,000 tons on the area of about 670 hectares. Its the biggest populations on mainland Japan Sea coast are situated in Chikhacheva bay to the north of Peter the Great Bay, over 20,000 tons on the area of 640 hectares.	Paper (in Russian)	Izvestia TINRO	170	17-29	Zostera marina Zostera asiatica Phyllospadix iwatensis	Sovetskaya Hr.	49.00167	140.28494	No	development of the port, pollution	No
Kolpakov N.V.	2013	Primery production of macrophytes in estuaries of Primorye	In results of the studies in 2008-2012, the area of thickets, the average biomass, the maximum total aboveground biomass of thickets of Zostera marina and Zostera japonica in the estuaries of the rivers Tesnaya, Gladkaya, Shkotovka and Sukhodol (Peter the Great Bay), Avvakumovka (Central Primorye) were defined. The annual productions of the sea grass beds in the studied estuaries were determined.	Paper (in Russian)	Izvestia TINRO	174	135-148	Zostera marina Zostera japonica	river Tesnaya river Gladkaya Shkotovka day Sukhodol bay Avakumovka bay	42.67579 42.68618 43.30067 43.20578 43.71471	130.67898 130.74381 132.33667 132.37033 135.22781	No		No
Scriptsova A.V., Kalita T.L., Nabivailo Yu.V.	2013	Evaluation of the state of the community Zostera marina+Sargassum under conditions of anthropogenic pollution	The state of the phytocenoses of Zostera marina+Sargassum were examined for eutrophic area at Cape Krasny (Amur Bay) and mesotrophic area at Cape Zelyony (Ussuri Bay) in June 2009. Both areas are located in Peter the Great Bay, the Sea of Japan. In total, 55 species of macrophytes were registered at Cape Zelyony (Chlorophyta - 9, Rhodophyta - 26, Phaeophyceae - 18 and 2 species of seagrasses) and 34 species - at Cape Krasny (Chlorophyta - 3, Rhodophyta - 25, Phaeophyceae - 5, and 1 species of seagrasses). The eutrophic area of Cape Krasny is distinguished by atypical for Peter the Great Bay species composition with low diversity, absence of many common species and relatively high biomass of coralline algae whereas the Zostera marina+Sargassum pallidum community in the mesotrophic area at Cape Zelyony could be characterized as a violated one.	Paper (in Russian)	Izvestia TINRO	174	257-270	Zostera marina	Cape Krasny (Amur Bay) Cape Zelyony (Ussuri Bay)	43.20439 43.18412	131.91984 132.11713	No		No

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Chinese version)	Type of publication(paper	Name of journal	Volume	Pages	Segrass species	Name of location	Coordinates (latititude and lontitude in Latitude	 Lontitude	Threats of seagrass reported? (Yes or No)	Describe details of those threats if	Are GIS polygon data for mapping
Kalita T.L., Scriptsova A.V.	2014	Current status of subtidal macrophyte communities in Ussuriysky and Amursky bays, the Sea of Japan	The subtidal macrophytes communities in selected localities of Amursky Bay (a cove south of Cape Krasny) and Ussuriysky Bay (a cove south of Cape Zeleny), Sobol Bay, and and at the southern extremity of Engelm Island) were studied by the quadrant sampling method in June 2009. In total, 12 phytocenoses were identified at the four sites. The vegetation at cape Zeleny was represented by three phytocenoses: Zostera marina+ Sargassum pallidum , Punctaria plantaginea, and Costaria costata+ Desmarestia ligulata. Four phytocenoses occurred in Sobol Bay: Phyllospadix iwatensis, Sargassum psllidum + Costaria coctata, Polysiphonia morrowii+ Palmaria stenogona, and Desmarestia viridis+ P. morrowii. Three phytocenoses were found at the southern coast of Engelm Island: Chordaria flagelliformes+ Neorhodomela larix, Desmarestia viridis, and Costaria costata. Two phytocenoses were described from the cove south of Cape Krasny: Zostera marina+ Sargassum miyabei, and Saccharina cichorioides. Detailed descriptions of the phytocenoses and biomass data for dominant and auxiliary species are given. The obtained data on the composition of the macrophytobenthic communities can be useful for coastal marine ecosystem monitoring programs in Peter the Great Bay.	Paper (in Russian)	Russian Journal of Marine Biology	v. 40, № 6	427-434	Zostera marina, Phyllospadix iwatensis	Cape Zelyony Cape Krasny Sobol Bay Engelm Island	43.18412 43.20439 43.07522 42.96531	132.11713 131.91984 131.96429 131.80492	No		No
Zharikov V.V. Bazarov K.Yu. Egidarev E.G. Lebedev A.M. Lysenko V.N.	2015	Mapping of underwater lansscapes of the Far Eastern Marine Reserve (Peter The Great Bay, the Sea of Japan) using remote sensing data	The article considers the selection criteria and methods for processing of remote sensing data form apping sea shallows. On the example of the study area the principles and algorithms of interpretation of images, the issues of providing work of field materials are discussed. The results of the expert and automatic interpretation of satellite data are presented. The prospects of cartographic monitoring of landscape diversity were shown.	Paper (in Russian)	Proceedings of the XV Conference of Geographers of Siberia and Far East		500-503	Zostera marina	Srednaya bay	42.64385	131.21207	No		Yes
Kolpakov N.V., Olkhovik A.V.	2015	Composition, distribution, and seasonal dynamics of vegetation in the estuaries of the Olga Bay (central Primorye)	Twenty-one species of water plants are found in the Avvakumovka River estuary and fourteen species — in the Olga River estuary in 3 surveys conducted in May, July, and September of 2012. Zostera marina dominates in the external estuary of both rivers in any season, whereas Potamogeton spp. and Ruppia maritima are the most abundant in some local areas of the Avvakumovka external estuary and Zostera japonica — in some local shallow areas of the Olga external estuary (where it forms perennial settlements). Chaetomorpha linum is the subdominant species in the Olga external estuary. In the Avvakumovka internal estuary, Cladophora glomerata and Z. marina are the dominants in May, Z. marina — in July, and Z. marina and Potamogeton spp. — in September, but any bottom vegetation is absent in the Olga internal estuary. From May to September of 2012, the summary biomass of water vegetation in both estuaries increased in 5 times: from 0.3 to 1.5 thousand tons. The data on composition, distribution and seasonal dynamics of estuarine vegetation in Olga Bay (central Primorye) are given. Some features of biology of one of the dominant species of plants - Zostera japonica are described. The biomass of Zostera marina in the estuary of the Avvakumovka River varied from 800 to 1500 g/m^2 (on average 700 g/m^2), the stock is estimated at 239 tons under the projective coverage from 20 to 90%. Under the projective coverage of thickets of Zostera japonica 10-50%, biomass makes 60 -120 g/m^2 (on average 90 g/m^2), and the stock is estimated at 3 tons. The thickets of Zostera marina in Tikhaya cove under projective coverage 40-70%, biomass makes 1000-1500 g/m^2 (on average 1200 g/m^2), and the stock is amounted to 41 tons. The thickets of Zostera japonica under projective coverage 20-50%, the biomass makes 180-400 g/m^2 (on average 210 g/m^2), the stock is estimated at 1 tone. Zostera marina dominates in the estuary of the Avvakumovka River throughout the growing season. Zostera japonica forms perennial populations in Olga Bay.	Paper (in Russian)	Izvestia TINRO	181	35-48	Zostera marina Zostera japonica	Olga Bay	43.68696	135.23735	no		No
Kulepanov V.N., Sokolenko D.A., Sedova L.G.	2015	Modern condition of Zostera beds in the coastal waters of Prymorsky region	**The description of modern condition of Zostera beds in northern coast of Primorski Krai is given.** The studies of the 2000s showed that the large Zostera populations have not changed their condition over the past 30 years. In comparison of the figures of the 1970s and 2000s, one can note that in some areas there was an increase in the areas of thickets (Kit cove, Milogradovo cove), in other parts the areas of thickets have not changed significantly (Olga cove, Moryak-Rybolov cove), and in others their decline (Rynda Bay, Matrosskaya cove). The total area of Zostera fields in the coastal waters of northern Primorye has increased from 2.2 thousand hectares to 3.2 thousand hectares.	Paper (in Russian)	Natural resources, their current state, conservation, commercial and technical use		98-99	Zostera marina Zostera asiatica	Kit bay Mylogradovka bay Moryak-Rybolov bay Rynda bay Matrosskaya bay	43.06453 43.29064 43.34678 43.02559 43.32276	134.19534 134.68556 134.79229 131.79605 134.78315	No		No
Zenkina V.G., Pavlova A.V.	2016	Growth dynamics of the seagrass Zostera japonica at its upper and lower distributional limits in the intertidal zone	This article discusses the most informative indicators of bio-indication in marine waters in Peter the Great Bay (The Sea of Japan) with the use of eelgrass Zostera marina. The depth of growth of eelgrasses, the width of the thickets, the density of the growth and morphology of shoots were analyzed in the waters of the bay. It was demonstrated that among them only the density of growth of Zostera marina shoots is significantly different in pure and polluted waters, which allows us to recommend this option as an indicator of ecological state of Peter the Great Bay.	Paper (in Russian)	International Journal of experimental education	10	190-192	Zostera marina	Tikhaya Zavod bay Zhitkov bay Cape Krasny Cape Zelyony Tokarevsky koshka	42.89341 43.20439 43.18412 43.07663	132.72823 131.91984 132.11713 131.84297	No		No
Zharikov V.V., Bazarov K.Yu., Egidarev E.G., Lebedev A.M., Lysenko V.N.	2015	Mapping of higher aquatic vegetation in the eastern section of the Far Eastern Marine Reserve using data of LANDSAT-8	Two methods of radiometric correction were used to comple the maps of sea grasses in the eastern section of the marine reserve. Estimation of accuracy of mapping has shown that the use of the bottom reflective index provides a more accurate map in comparison with the depth-invariant index. The areas of overgrowth were calculated by using data of 2001, 2013 and 2014. The availability of processing methods of the remote sensing data to monitor the coastal waters vegetation was verified.	Paper (in Russian)	Geosystems and their components in Northeastern Asia: evolution and dynamics of natural, natural and resource, and social and economic ties.		183-188	Zostera marina	Srednaya bay	42.64385	131.21207	Yes	typhoon	Yes
Zharikov V.V., Smirnova E.V., Lebedev A.M.	2016	Ecological-landscape assessment of the current state of biota in Severnaya inlet (Amursky Bay, The Sea of Japan)	The assessment of the communities and state of habitats in Severnaya inlet (Amursky Bay, Peter the Great Bay, The Sea of Japan) was carried out to determine the macrobenthos taxonomic composition and quantitative indicators. Detailed bottom topography and sediments distribution maps were compiled. Macrozoobenthos is dominated by polychaetes, clams, starfish. The average biomass of zoobenthos was 100-300 g / m 2.	Paper (in Russian)	The Scientific Works of Far Eastern State Technical Fisheries University	2	11-16	Zostera marina	Severnaya bay	42.93046	131.40003	Yes	development of the port, pollution, aquaculture	Yes
Kalita T.L., Scriptsova A.V.	2017	The modern state of Zostera marina community at Tokarevsky Koshka (The Sea of Japan)	**In June 2014, the seagrasses community was studied by the method of sample plots in the bay formed of Tokarevsky Koshka (Eastern Bosporus strait, The Sea of Japan). Taxonomical, morphological-functional composition and structure of the benthic macrophyte community were investigated. In this area, 39 species of the marine macrophytes including** Chlorophyta - 6 (15%), Rhodophyta -22 (56%), Phaeophyceae - 10 species (26%) и 1 seagrass - ***Zostera marina*** **(3%) were identified in total. The poor taxonomic composition, high abundance of opportunistic species and their emergence to the role of auxiliary species were characteristic of phytocenosis seagrasses in the area of Tokarevsky Koshka.** At the same time the proportion of higher taxa were typical of the clear waters of Peter the Great Bay. So, phytocenosis ***Zostera marina + Stephanocystis crassi***pes, located in the bay at Tokarevsky Koshka can be regarded as a destroyable one, as being in the early stages of anthropogenic transformation and waters classified as a temperate polluted.		Russian Journal of Marine Biology	in press		Zostera marina	Tokarevsky koshka (Eastern Bosporus strait)	43.07663	131.84297	Yes	development of the port, pollution,	No

Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Korean version)	Type of publication(paper,	Name of journal	Volume	Pages	Seegrass species	Name of location	Coordinates (latititude and apping a pin.	Lontitude	Threats of seagrass	Describe details of those threats if	Are GIS polygon
2008	Distribution of a map on spawning grounds of Pacific herring ニシン産卵藻場マップが配布される	Wakkanai Fisheries Research Institute published a map on seagrass and seaweed distributions where Pacific herring, Clupea pallasii spawn around Cape Noshappu near Wakkanai, northern Hokkaido Island, Japan by analyzing aerial photography.	report	Current progress of research Marinet（試験研究は	627	N.A	Phyllospadix iwatensis	Fujimi, Cape Noshappu, Hokkaido Island	45.43556	141.63778	No		No
1998	Searching spawning grounds of Pacific herring ニシンの産卵場所を探す	Researchers of Wakkanai Fisheries Research Instituute found eggs of Pacific herring, Clupea pallasii on one seagrass species, Phyllospadix iwatensis and one Sargassum specie, Sargassum confusum C. Agardh 1824 around Rumoi in northern Hokkaido Island, Japan in March 1998.	report	Current progress of research Marinet（試験研究は	347	N.A	Phyllospadix iwatensis	Estuary of Rumoigawa River, Hokkaido Island	43.96056	141.64083	No		No
1987	Relation between shoot and seed distributions of eelgrass bed	Distribution of shoot and seed of eelgrass Zostera marina, were compared in an eelgrass bed in Okayama Prefecture, the Seto Inland Sea. The former was observed by SCUBA diving on June 4th, 1981 and the latter was surveyed by collecting mud samples with a grab-type bottom-sampler on August 17th, 1981. The distribution of shoot and seed were closely related with each other, the points of denser distribution of shoot showing denser distribution of seed. The results suggest that the distribution of seed is an important factor for existence of eelgrass bed. It will be possible to create eelgrass bed artificially by sowing eelgrass seeds at the place where surrounding conditions are suitable.	paper	Nippon Suisan Gakkaishi	53 (10)	1755-1758	Zostera marina	Ushimado, Okayama	34.6083328	134.1357911	No		No
2005	Effects of light reduction by sediment deposition on leaves and sand movement on eelgrass distribution (Zostera marina L.) at Hiroshima Bay in the Seto Inland Sea, Japan. (In Japanese)	The objective of this study is to clarify the effect of light reduction by sediment deposition on leaves and sand movement on eelgrass distribution for obtaining fundamental knowledge on the formation of the eelgrass (Zostera marina L.) habitat. We investigated light regime and sediment deposition on leaves near the lower edge of an eelgrass bed, and monitored sand movement and transplanted eelgrass in an unvegetated site near the higher edge. The average light intensity through sediment deposition on eelgrass leaves was estimated to be approximately 3 E m-2 d-1 <. Sand movement at the unvegetated site ranged from -10 cm to 12 cm and was more unstable than that at a natural site. Scouring for two months reached up to 10 cm, and seedlings disappeared at the unvegetated site near the higher edge. However, the number of vegetative shoots in the unvegetated site steadily increased. These results suggest that vegetative shoots can survive within 10 cm washouts and the growth of eelgrass near the higher edge of an eelgrass bed is restricted to vegetative reproduction.	paper	Journal of Japan Society on Water Environment	28 (4)	257-261	Zostera marina	Iwakuni, Yamagchi Prefecture	34.1277352	132.2360866	No		No
1997	Technology development experiment for creating spawning grounds of Pacific herring ニシン産卵藻場造成技術開発試験について	Central Fisheries Institute of Hokkaido conducted surveys on seagrass and seaweed distributions by 19 line from the shore to 100 m offshore and quadrat sampling at 209 stations along the lines around Atsuta Village northwest coast of Hokkaido Island, Japan. Three dominant plants were kelp, Phyllospadix iwatensis and Stephanocystis hakodatensis in order of standing crop.	report	Hokkaido Fisheries Experimental Station Newslett	38	13-16	Phyllospadix iwatensis	Ishikari	43.39583	141.42806	No		No
2001	Where do Pacific herring spawn? An example of Atsuta Villge ニシンはどんな場所に産卵するのか一厚田村の場合一	Marine plants that Pacific herring, Clupea pallasii spawned were investigated along the coast of Atsuta Village, northwest of Hokkaido Island in 1996 and 1997. They were Phyllospadix iwatensis, Stephanocystis hakodatensis, Sargassum confusum and Mazzaella japonica. However, Pacific herring eggs were mostly attached on fronds of P. iwatensis.	report	Hokkaido Fisheries Experimental Station Newslett	53	14-17	Phyllospadix iwatensis	Ishikari	43.36167	141.42583	No		No
2004	What is Phyllospadix iwatensis that recently attracts attention as spawning substrate for Pacific herring 最近、ニシンの産卵基質として注目されている海草スガモとは？	Pacific herring, Clupea pallasii spawn their eggs on Phyllospadix iwatensis leaves. It was verified that their spawning grounds around Atsuta Village, Zenibako of Otaru City in 2002 and Yoichi Town in 2004. P. iwatensis is very important for Pacific herring population near Hokkaido. Ecology of P. iwatensis was introduced.	report	Hokkaido Fisheries Experimental Station Newslett	63	7-10	Phyllospadix iwatensis	Yoichi	43.24444	140.72417	No		No
2006	Present status on geographical distributions of Zostera species along the coast of northern Hokkaido Island 北海道北部沿岸におけるアマモ類の分布の現状	The authors investigated seagrass distributions in an area of Soya Branch Office of Hokkaido Prefecture by observation with lowered underwater camera and diving in 2005 and 2006. They found 8 locations where seagrass species were distributed and sampled specimens. Species were Zostera marina, Zostera japonica, Zostera caespitosa, Zostera asiatica and Phyllospadix iwatensis.	report	Hokkaido Fisheries Experimental Station Newslett	73	11-15	Zostera caespitosa Phyllospadix iwatensis Zostera marina Zostera asiatica Zostera japonica	Fujimi	45.42583	141.63556	No		No
								Souya(ryuujin-iwa)	45.49778	141.96722	No		No
								Nishikama(Sakanoshita-kaisuiyokujo)	45.37611	141.65056	No		No
								Kutsugatashinminato	45.20333	141.13778	No		No
								Funadomari	45.44222	141.03528	No		No
								Esanuka	45.24333	142.31167	No		No
								Hamatonbetsu	45.19194	142.51694	No		No
								Poro-numa	45.28139	142.22889	No		No

Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Korean version)	Type of publication(paper,	Name of journal	Volume	Pages	Seagrass species	Name of location	Coordinates (latititude and apping a pin.	Lontitude	Threats of seagrass	Describe details of those threats if	Are GIS polygon
2007	Surveys on distributions of Zostera species along the Pacific coast in southern Hokkaido 道南太平洋海域のアマモ類分布調査	Muroran Branch of Hakodate Fisheires Institute surveyed seagrass distributions and their samples for "Research on development of seagrass bed creation techniques considering biodiversity" funded by Fisheries Agency of Japan from 2006 to 2008. The researcher found and sampled seagrass species at 13 locations from southern Hokkaido coast except that from east Iburi to west Hidaka.	report	Hokkaido Fisheries Experimental Station Newslett	74	12-14	Phyllospadix iwatensis Zostera marina Zostera caespitosa Zostera asiatica	Hon-Cho	42.01361	143.14667	No		No
								Usu	42.51861	140.78278	No		No
								Fuyuni(Shiogamaroosoku-iwa)	42.13167	142.89667	No		No
								Touyo(Touyo-Tonneru)	41.95472	143.20722	No		No
								Erimo-misaki(Shin-koh)	41.93861	143.2425	No		No
								Usu(Usuwan-kuchi)	42.51611	140.77833	No		No
								Minamiusu(Entomo-misaki)	42.48444	140.79778	No		No
								Minamiusu	42.5	140.79583	No		No
								(arutori-misaki)	42.495278	140.77361	No		No
								Charatsunai	42.30722	140.98167	No		No
								Mitsuishikoshiumi	42.25861	142.52611	No		No
								Kojouhama(ayoro-iseki)	42.45167	141.1975	No		No
								Sunahara	42.125	140.64583	No		No
								Usujiri(Benten-misaki)	41.93694	140.94944	No		No
								Choushi	41.85278	141.15	No		No
								Ooma	41.74667	141.07722	No		No
								Fukuyama	41.4275	140.11056	No		No
								Moheji-gyokoh	41.75778	140.60611	No		No
								Kikonai	41.69667	140.48389	No		No
2002	List of marine plants from the coast of Ishikawa prefecture. (In Japanese)	The present paper deals with the flora of seaweeds and seagrasses on the coast of Ishikawa Prefecture. The fieldwork was carried out during the period from January 1997 to January 2000. The numbers of species collected was 197 including 23 species of Chlorophyceae, 58 species of Phaeophyceae, 111 species of Rhodophyceae and 5 species of marine flowering plants.	paper	Bulletin of Ishikawa Prefecture Fisheries Researc	3	1月11日	Zostera marina Zostera japonica Halophila ovalis Zostera caespitosa Phyllospadix japonicus	Mimuro, Nanao City	37.0902976	137.0117971	No		No
								Mimuro, Nanao City	37.0902976	137.0117971	No		No
								Mitsuke, Suzu City	37.3983886	137.245804	No		No
								Mitsuke, Suzu City	37.3982746	137.245993	No		No
								Bentenzaki, Anamizu City	37.2138024	137.0655142	No		No
								Hachigasaki, Notojima Island	37.1652618	137.0447451	No		No
								Hachigasaki, Notojima Island	37.1652618	137.0447451	No		No
								Katano, Kaga City	36.3250713	136.2763813	No		No
								Kurosaki, Kaga City	36.3390436	136.2886458	No		No
								Takayamachi, Suzu City	37.5309289	137.2608021	No		No
								Hukamimachi, Wajima City	37.4212373	136.9837239	No		No
								Koura, Notojima Island	37.2970813	137.1944392	No		No
2001	Distribution of endangered aquatic macrophytes in Lakes Shinji and Nakaumi. (In Japanese)	This paper describes the results of observation on the distribution of endangered aquatic macrophytes in Lake Shinji and Nakaumi, southwestern Honshu, Japan. Distribution of six submerged (Potamogeton pectinatus L., P. panormitanus Biv., Ruppia maritima L., Zannichellia palustris L., Chara corallina Willdenow var. kyushuensis Imahori and Zostera japonica Ashers et Graebn.) and one emergent macrophyte (Carex rugulosa Kükenth) are shown and their characteristics features are also shown.	paper	Laguna	8	95-100	Zostera japonica	Lake Nakaumi	35.491171	133.2247188	yes	y will be decreased.	No
								Lake Nakaumi	35.4518628	133.128638	yes	y will be decreased.	No
								Lake Shinji	35.4676831	133.0537245	yes	y will be decreased.	No
								Lake Shinji	35.4678044	133.0561116	yes	y will be decreased.	No
								Ohashi River	35.4671046	133.0630715	yes	y will be decreased.	No
								Ohashi River	35.4675133	133.0616817	yes	y will be decreased.	No
								Ohashi River	35.4625498	133.0878663	yes	y will be decreased.	No
								Ohashi River	35.4624775	133.0893396	yes	y will be decreased.	No
								Ohashi River	35.4518914	133.1039359	yes	y will be decreased.	No
								Lake Nakaumi	35.4601213	133.1263138	yes	y will be decreased.	No
								Lake Nakaumi	35.4522416	133.1464709	yes	y will be decreased.	No
								Lake Nakaumi	35.4477735	133.1585065	yes	y will be decreased.	No
								Lake Nakaumi	35.4362344	133.1758943	yes	y will be decreased.	No
								Lake Nakaumi	35.4383788	133.1986021	yes	y will be decreased.	No
								Lake Nakaumi	35.4489427	133.2110318	yes	y will be decreased.	No
								Lake Nakaumi	35.455929	133.2589229	yes	y will be decreased.	No
								Lake Nakaumi	35.447806	133.2141488	yes	y will be decreased.	No
								Lake Nakaumi	35.4861471	133.2296443	yes	y will be decreased.	No
								Lake Nakaumi	35.5123627	133.1870579	yes	y will be decreased.	No
								Lake Nakaumi	35.4837858	133.1775216	yes	y will be decreased.	No
								Lake Nakaumi	35.5259719	133.195946	yes	y will be decreased.	No
								Lake Nakaumi	35.5080219	133.1674444	yes	y will be decreased.	No
								Lake Nakaumi	35.486788	133.1559395	yes	y will be decreased.	No
								Lake Nakaumi	35.4858125	133.1473508	yes	y will be decreased.	No
								Lake Nakaumi	35.4996698	133.1362841	yes	y will be decreased.	No
								Lake Nakaumi	35.5115388	133.1318924	yes	y will be decreased.	No
								Lake Nakaumi	35.5351542	133.1539821	yes	y will be decreased.	No
								Lake Nakaumi	35.5362668	133.1602402	yes	y will be decreased.	No
								Lake Shinji	35.4715115	133.0215102	yes	y will be decreased.	No

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Sakuno, Y., Sochea, L., Kunii, H., T	2009	Estimation of Zostera bed coverage using Balloon with video camera. (In Japanese)	Estimation of Zostera bed coverage using balloon with digital video camera in Lake Nakaumi, Shimane Prefecture, Japan was tried. The simultaneous field survey was done in Tonoe water region and in the southeast shore of Moriyama Dike on May 30, 2008. As a result, it was confirmed that the Zostera bed coverage of 200 – 250 m scale was distributed in these areas by using the video data. Moreover, the method of classifying the marine forest from RGB data of the video images was shown by applying "Bottom Index (BI)" method. Finally, it was shown that the BI method was effective for the Zostera bed coverage extraction in the lake.	paper	Proceedings of hydraulic engineering	53	1357-1362	Zostera marina	Lake Nakaumi	35.5332439	133.2031611	No		No
									Lake Nakaumi	35.5174525	133.1854858	No		No
									Lake Nakaumi	35.5307051	133.2007779	No		No
Nabata, S., Abe E., Kakiuchi, M.	1992	On the "Isoyake" condition in Taisei-cho, southwestern Hokkaido	The authors studied quantitative distributions of animals and plants in barren area off Taisei-cho located in southwest Hokkaido Island and observed formation process of seaweed beds after deployment of substrates from 1985 to 1986.	report	Scientific report of Hokkaido Fisheries Experimen	38	1-14	Phyllospadix iwatensis	Taisei(Nagaiso)	42.143056	139.91472	No		No
Agatsuma, Y.	1997	Ecological studies on the Population dynamics of the sea urchin Strongylocentrotus nudus.	Ecological studies on the population dynamics of the sea urchin Strongylocentrotus nudus have been carried out at 13 survey sites off the coast of southern Hokkaido from 1980 to 1995. The reproductive cycle, occurrence of echinopluteus larvae, recruitment of the 0 year-old juveniles, process of somatic and gonadal growth attributable to algal feeding, and the environmental factors leading to annual fluctuations in the number of juvenile recruits and the subsequent commercial catch have been detailed from data collected over this period. In order to form algae communities on coralline flats where only crustose coralline algae occur (termed "Isoyake" in Japanese), the succession of marine algae after the removal of sea urchins was studied. Furthermore, in order to establish the enhanced culture of S. nudus on coralline flats where previously there was no commercial catch, field experiments on gonadal increment have been carried out.	report	Scientific report of Hokkaido Fisheries Experimen	51	1-66	Phyllospadix iwatensis	Mitsuya-Genwa	42.01917	140.10028	No		No
									Esan-Hiura	41.77083	141.09611	No		No
									Narugami	42.13	139.96806	No		No
									Yoshioka	41.44528	140.23694	No		No
									Kerimai	42.22278	142.62528	No		No
									Fukushima Iwabe	41.51472	140.37111	No		No
Hoshikawa, H., Tajima, K., Kawai, T	2002	Effect of vegetation and topography on the spawning bed selection of herring, Clupea pallasii	Pacific herring (Clupea pallasii) spawn in Atsuta, on the west coast of Hokkaido, northern Japan, was surveyed by divers in 1998 and 1999. Some grooves existed on the flat rocky shore developed at Minedomari, Atsuta. Spawning beds of herring were located near the grooves year by year. Herring used seagrass, Phyllospadix iwatensis, as spawning substratum. Maximum egg density was 101,375 per small quadrate (0.25 m x 0.25 m) in 1998. Seagrass biomass affected egg density. Seagrass biomass, leaf density and number of eggs per seagrass biomass unit were significantly higher within grooves outside of them. These surveys showed that egg distribution is dependent on the seagrass density and the groove existence on the rocky shore available for use as a passage to enter the shallower area at Minedomari, Atsuta.	report	Scientific report of Hokkaido Fisheries Experimen	62	105-111	Phyllospadix iwatensis	Minedomari	43.33556	141.4225	No		No
Hoshikawa, H., Tajima, K., Kawai T	2002	Water temperature and salinity in the spaqwning bed of hering (clupea pallasii), and estimating of spawning preriod based on the water temperature	Water temperature and salinity in herring spawning beds on the rocky shore were surveyed at Minedomari, Atsuta, Hokkaido during the 2000 spawning season. Water temperature was 4° C during mid-March spawning and 7-8° C at the mid-April hatch. Average temperature was 5.2° C in the spawning bed and 4.7° C at deeper bottom off Minedomari. Cumulative temperature from spawn to hatch was 138.8° C in the spawning bed. This value was almost equal to the 136° C obtained in the laboratory where eggs were kept under 8.5° C. Spawning period in field could be estimated based on cumulative temperature for respective developmental stages and water temperatures. Salinity changed very widely from 7 psu to over 30 psu after the end of March due to melting snow. Spawning on the shallow rocky shore at Atsuta adapted to reduce the incubation period through higher temperature and obtain good conditions for development and hatch out through adequate salinity.	report	Scientific report of Hokkaido Fisheries Experimen	62	113-118	Phyllospadix iwatensis	Minedomari	43.33556	141.4225	No		No
Akaike, S., Tada, M., Takiya, A., Im	2002	Natural spawning beds of herring in the Rumoi distinct along the coast of northwestern Hokkaido from 1998 to 2001	Natural spawning beds of herring (Clupea pallasii) were investigated along the Rumoi coast. Hokkaido. Japan from 1906 to 2001. Seven spawning beds were found at seaweed beds shallower than 2 m deep from 1998 to 2001. Milky-white turbidity of the sea surface due to herring spawning was observed in three times (Reuke in 1999, 2001 and Onishika in 2001). Estimated total number of eggs ranged from 84.5x10ˆ6 to 263.1 x10ˆ6, average egg density ranged from 10834 to 571000/m2, and maximum egg density ranged from 176 x10ˆ3 to 2.5 x I0ˆ6/m2. Species of seaweeds attached with the large number of eggs were Phyllospadix iwatensis. Sargassum confusum and Coccophora langsdorfii. Daily average of water temperature during spawning periods ranged from 2.8 to 4.7° C. Spawning bed salinity in these periods was diluted and fluctuated due to melting snow. On spawning days, it was calm with the character of low wave height, low wave velocity, easterly winds, and cloudy sky. Spawning herring schools were beloved to approach spawning beds from offshore through sea-floor trenches.	report	Scientific report of Hokkaido Fisheries Experimen	62	91-103	Phyllospadix iwatensis	reuke	43.91472	141.61583	No		No

Author names	Year	Title of publication	Abstract (If English abstract is not availabe, please copy and past Korean version)	Type of publication(paper,	Name of journal	Volume	Pages	Seagrass species	Name of location	Coordinates (latititude and apping a pin.	Lontitude	Threats of seagrass	Describe details of those threats if	Are GIS polygon
Kaneta, T., Sakurai, I.	2006	Growth and maturation of the perennial brown alga Sargassum confusum adhered on concrete plates	In order to develop a technique for algal bed formation, the growth and maturation of the perennial brown alga Sargassum confusum that adhered to concrete plates were examined. The concrete plates were placed at the ground level in the area with S. confusum vegetation at Minedomari, Atsuta, in July 2000. The plates were then relocated at a depth of 1 m and 3 m in December 2000, at 5 m in January 2001 in the same area, and at 1 m in January 2003 in the southern part of the area where Pacific herring spawn. The length of S. confusum on the plates was measured. The mean length of S. confusum on the plates set under severe wave conditions (depth: 3 m) was lesser than that under calm wave conditions (depth: 1 m and 5 m). The mean length of S. confusum on the plates was lesser than that observed in natural vegetation around the plates at the southern area. The maturation of S. confusum was observed on the plates at the age of three years. These results suggest that algal bed formation should be carried out for three successive years.	report	Scientific report of Hokkaido Fisheries Experimen	70	113-117	Phyllospadix iwatensis	Minedomari	43.34778	141.42083	No		No
Ueda, S., Chikuchi, Y. and Kondo,	2006	Horizontal distribution and natural resource of seagrass in brackish Lake Obuchi, Aomori Prefecture, Japan. (In Japanese)	The horizontal distribution and quantity of natural resources of seagrass (Zostera marina and Zostera japonica) in brackish Lake Obuchi, located in the center of the Shimokita Peninsula in Aomori Prefecture, were observed by image analysis of an aerial photograph and aqualung diving from June 2004 to April 2005. Distributed water depth of Zostera marina and Zostera japonica were approximately 1 – 1.5 m and < 0.5 m, respectively. Total area of seagrass in the lake was approximately 0.08 km2, which the corresponding area to 2% of the surface area of the lake. Maximum and minimum values of total quantity of natural resources (a leaf and root parts) of seagrass in the lake were showed approximately 72 t (June) and 22 t (April), respectively. The total quantity of natural resources of seagrass in this work was approximately similar to that of approximately 30 – 40 years ago.	paper	Japanese Journal of Limnology	67	113-121	Zostera marina	Lake Obuchi	40.958055	141.35672	Yes	ophication and herb	No
Yoshimura, K. 吉村圭三	2007	Surveys on Zostera Zostera species along the Pacific coast in southern Hokkaido Island 道南太平洋海域のアマモ類分布調査	Muroran Branch of Hakodate Fisheires Institute surveyed seagrass distributions and their samples for "Research on development of seagrass bed creation techniques considering biodiversity" funded by Fisheries Agency of Japan from 2006 to 2008. The researcher found and sampled seagrass species at 13 locations from southern Hokkaido coast except that from east Iburi to west Hidaka.	report	Hokkaido Fisheries Experimental Station Newslett	74	12-14	Phyllospadix iwatensis	N.A	41.9510709	143.2917357	No		No
									N.A	41.9206467	143.1783925	No		No
									N.A	41.8528389	141.1633265	No		No
									N.A	41.7241105	141.0675488	No		No
									N.A	41.6833843	140.4666555	No		No
									N.A	41.967626	140.9439335	No		No
									N.A	42.0941562	142.9271919	No		No
									N.A	42.279922	142.3546268	No		No
									N.A	42.4447281	141.232101	No		No
									N.A	42.2998967	140.9711306	No		No
									N.A	42.1345992	140.6906893	No		No
									N.A	41.4120096	140.1447119	No		No
									N.A	42.4905479	140.7777087	No		No
Takayama, Y., Ueno, S., Katsui, H.	2003	HIS model on eel grass beds based on their distributions in Ena Bay 江奈湾の藻場分布データに基づいたアマモのHSIモデル	The authors developed a Habitat Suitability Index (HIS) model that quantify habitat environments of Zostera marina. Using radiation on the sea bottom,	paper	Proceedings of Coastal Engineering, JSCE 海岸工	50	1136-1140	Zostera marina Zostera japonica	Ena Bay	35.1453877	139.6673031	No		No
									Ena Bay	35.1462916	139.6656136	No		No
Department of Environment and I	2006	Outline of environment iprovement experimental project in 2005 with useful microorganisms平成17年度 有用微生物による環境改善実験事業(英虞湾浄化調査)の概要.	Department of Environment and Forests, Mie Prefecture surveyed seagrass and seaweed beds in Katada and Shinmei areas in Ago Bay, Mie Prefecture from 2003 to 2005 with marine environments.	report	N/A	N/A	N/A	Zostera marina Zostera japonica	N.A	34.2624012	136.8292558	No		No
									N.A	34.3132426	136.8232658	No		No
									N.A	34.2616408	136.8358348	No		No
									N.A	34.2607865	136.8299277	No		No
									N.A	34.2612734	136.8344326	No		No
									N.A	34.2615861	136.8286773	No		No
Yamaki, K., Shinpo, Y., Tanaka, M.	2006	Understanding the actual conditions of ell gras bed expansion and an experiment to form a new eel grass bed by transplantation アマモ場拡大の実態把握と種苗移植による新規群落形成の試み.	In order to clarify a mechanism to form a new community of Zostera marina, the authors continued field observation to monitor a Z. marina bed newly formed during three years and also simulated seed supply by a numerical model. The filed observations reavealed that dynamics of Z. marina community was influenced by a water temperature and a light environment. The numerical simulation showed that seeds were settled on the sand bed under offshore wave with a wave height of 1.5 m and a period of 5 s and seeds were buried in the sand under a wave height of 2.0 m and a period of 7 s. A transplantation experiment of at a site where seeds and seedlings couldn't settle showed that seedlings with a shoot length of 110 mm artificially germinated could colonize and form a Z. marina community.	paper	Proceedings of Coastal Engineering, JSCE 海岸工	53	1006-1010	Zostera marina	N.A	35.2693209	139.5702906	Yes	ried in an area wher	No
a, T. and Mikami, A. 小松 輝久・佐	2006	Distributions of seagrass beds and their eoclogical roles in the tidal flat ecosystem干潟生態系における藻場の分布とその役割	The authors examined relations between seagrass beds and tidal flats distributed in different geomorphological areas: brackish lagoon (tidal flat in Saroma Lake in Hokkaido), the foreshore (tidal flat off Futtsu in Tokyo Bay) and the river mouth (tidal flat of Kushida River in Ise Bay) and discussed the importance of seagrass beds for tidal flats.	paper	Chikyu Kankyo 地球環境	11 (2)	207-213	Zostera marina Zostera japonica Zostera asiatica	Kushida River Estuary, Ise Bay	34.6061779	136.5795721	Yes	seagrasses grow ar	No
									Lake Saroma	44.1874203	143.6775087	No		No
									Lake Saroma	44.1111418	143.7294708	No		No
									Cape Futtsu, Tokyo Bay	35.3172898	139.8037385	No		No
									Cape Futtsu, Tokyo Bay	35.3159555	139.8066849	No		No
K. Itani, T. and Wada, Y. 西垣友和	2005	Relationship between Underwater Light Condition and Lower Depth Limit of Zostera marina in Coastal Area of Kyoto Prefecture 京都府沿岸における水中の光環境とアマモの分布下限水深の関係について.	The authors measured light environments of PAR in Zostera marina beds off Matsuzaki in Maizuru Bay and off Nagae in western Wakasa Bay at	report	refectural Marine Research Center 京都府立海洋	27	35-36	Zostera marina	off Nejirimatsuzaki, Maizuru Bay	35.4676284	135.3292166	Yes	seagrass leaves lov	No
									off Nagae, Wakasa Bay	35.6593176	135.2634318	No		No
Akaike, S. and Goda, K. 赤池章一	2006	Present status of Zostera species along the coast of northern Hokkaido Island 北海道北部沿岸におけるアマモ類の分布の現状	The authors investigated seagrass distributions in an area of Soya Branch Office by observation with lowered underwater camera and diving in 2005 and 2006. They found 8 locations where seagrass species were distributed and sampled specimens. Species were Zostera marina, Zostera japonica, Zostera caespitosa, Zostera asiatica and Phyllospadix iwatensis.	report	Hokkaido Fisheries Experimental Station Newslett	73	11-15	Zostera marina Phyllospadix iwatensis Zostera japonica Zostera asiatica Zostera caespitosa	N.A	45.4380043	141.0108507	No		No
									N.A	45.3869383	141.6290329	No		No
									N.A	45.3809709	141.6375042	No		No
									N.A	45.4941393	141.9764755	No		No
									N.A	45.3434013	142.1622563	No		No
									N.A	45.132276	142.4078044	No		No
									N.A	45.2448867	142.2872428	No		No
									N.A	45.4184756	141.8103833	No		No
									N.A	45.4384981	141.0138993	No		No
									N.A	45.395455	141.6235906	No		No

There are more information about literature being reviewed in Japan.

Annex 2

Country	Name of area	Area (km^2)	Sensor name	Aquision date	Data type	Resolution	Price per km^2	Price	Price in USD based on currency rate of Aug, 2017
China	Swan lake	16 km^2	Landsat MSS	1979/6/12	4 bands	80m	Free	Free	Free
		16 km^2	aerial photography	1984	1 band	2m			
		16 km^2	Landsat MSS	1989/5/1	4 bands	30m	Free	Free	Free
		16 km^2		1990/6/2	7 bands	30m	Free	Free	Free
		16 km^2	Landsat TM	1995/12/9	7 bands	30m	Free	Free	Free
		16 km^2	aerial photography	1997	1 band	2m			
		16 km^2	Landsat TM	2001/9/21	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2002/6/11	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2004/8/12	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2005/3/23	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2005/10/17	7 bands	30m	Free	Free	Free
		16 km^2	Worldview	2006/3/27	7 bands	2m	200 RMB	10000 yuan (RMB)	1450
		16 km^2	Landsat ETM+	2006/8/17	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2007/1/24	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2008/8/7	7 bands	30m	Free	Free	Free
		16 km^2	Landsat ETM+	2009/4/3	7 bands	30m	Free	Free	Free
		16 km^2	Worldview-2	2012/10/23	4 bands	2m	200 RMB	10000 yuan (RMB)	1450
		16 km^2	Worldview-2	2016/3/27	4 bands	2m	200 RMB	10000 yuan (RMB)	1450

Country	Name of area	Area (km^2)	Sensor name	Aquision date	Data type	Resolution	Price per km^2	Price	Price in USD based on currency rate of Aug, 2017
Japan	Himi (Toyama Bay)	109 km^2	GeoEye-1	2014/11/22	4 bands	2m	3,000円	247,212円 (-30% discount)	2200
		500 km^2	RapidEye	2016/3/17	5 bands	5m	260円	133,380円 (-5% discount)	1200
		35 km^2	Worldview-3	2016/11/13	8 bands	1.6m	3,800円	143,640円	1300
	Nanao Bay	50 km^2	Landsat-8 OLI	2015/6/1	4bands	30m	Free	Free	Free
			Landsat-8 OLI	2014/11/21	4bands	30m	Free	Free	Free
			Landsat TM	1991/11/22	4bands	30m	Free	Free	Free
			Landsat TM	1992/6/1	4bands	30m	Free	Free	Free
			Landsat TM	1994/3/3	4bands	30m	Free	Free	Free
			Landsat TM	1996/3/24	4bands	30m	Free	Free	Free
			Landsat TM	1999/3/1	4bands	30m	Free	Free	Free
			Landsat ETM+	2000/3/27	4bands	30m	Free	Free	Free
			Landsat TM	2004/2/11	4bands	30m	Free	Free	Free
			Landsat TM	2007/2/3	4bands	30m	Free	Free	Free
			Landsat TM	2008/3/12	4bands	30m	Free	Free	Free

Country	Name of area	Area (km^2)	Sensor name	Aquision date	Data type	Resolution	Price per km^2	Price	Price in USD based on currency rate of Aug, 2017
Korea	Jangheung Bay	16 km^2	Landsat 5TM	1990/5/21	7 bands	30m	Free	Free	Free
			Landsat 5TM	1991/12/2	7 bands	30m	Free	Free	Free
			Landsat 5TM	1992/10/2	7 bands	30m	Free	Free	Free
			Landsat 5TM	1993/1/5	7 bands	30m	Free	Free	Free
			Landsat 5TM	1994/5/16	7 bands	30m	Free	Free	Free
			Landsat 5TM	1995/12/27	7 bands	30m	Free	Free	Free
			Landsat 5TM	1997/3/5	7 bands	30m	Free	Free	Free
			Landsat 5TM	1999/3/11	7 bands	30m	Free	Free	Free
			Landsat 5TM	2000/3/13	7 bands	30m	Free	Free	Free
			Landsat 5TM	2001/4/1	7 bands	30m	Free	Free	Free
			Landsat 7ETM+	2002/2/7	8 bands	30m	Free	Free	Free
			Landsat 5TM	2003/12/3	7 bands	30m	Free	Free	Free
			Spot-4	2004/2/27	5 bands	10 m	$1.78	$1,600	1600
			Landsat 7ETM+	2005/4/4	8 bands	30 m	Free	Free	Free
			Kompsat-2	2007/12/20	4 bands	4 m	$8	$800	800
			Aster	2011/3/27	3 bands	15 m	$0.01	$223	223
			Kompsat-2	2012/1/7	4 bands	4 m	$8	$800	800
			Landsat 7ETM+	2013/9/17	8 bands	30 m	Free	Free	Free

Country	Name of area	Area (km^2)	Sensor name	Aquision date	Data type	Resolution	Price per km^2	Price	Price in USD based on currency rate of Aug, 2017
Russia	EASTERN SECTION OF THE FAR EASTERN MARINE RESERVE	60 km^2	Landsat 7 ETM+	2001/11/12	8 bands	30m	Free	Free	Free
			Landsat-5 TM	2009/10/9	7 bands	30m	Free	Free	Free
			Landsat 7 ETM+	2011/9/21	8 bands	30m	Free	Free	Free
			Landsat-8 OLI	2013/9/18	9 bands	30m	Free	Free	Free
			Landsat-8 OLI	2014/11/8	9 bands	30m	Free	Free	Free
	Southern section of the Far Eastern Marine Reserve	40 km^2	Landsat-8 OLI	2013/11/5	9 bands	30m	Free	Free	Free
	Gulf of Pos'eta	100 km^2	Landsat-8 OLI	2013/11/5	9 bands	30m	Free	Free	Free
	EASTERN SECTION OF THE FAR EASTERN MARINE RESERVE	20 km^2	SPOT-5	2012/10/23	5 bands	10 m	$20.00	$400.00	800
			IKONOS-2	2013/10/15	5 bands	3.2	$20.00	$400.00	800
Total									12623

Country	Name of area	Device used	Date	Ship charterage	Ship charterge in USD based on rate of Aug, 2017
China	Swan Lake	Echosounder	2016/5/16, 2016/5/17	US $ 1500 ($ 750 per day)	1,500
Japan	Nanao Bay	Under water came	2015/6/1, 2015/6/2, 2015/6/16	60000 JPY (20000 JPY per day)	550
	Himi	Under water came	2015/7/1, 2015/7/15, 2015/7/16	120000 JPY (40000 JPY per day)	1,100
Korea	EASTERN SECTION OF THE FAR EASTERN MARINE RESERVE	Under water camera, echosounder and SCUBA transects	2015/07/21, 2015/07/22, 2015/07/23, 2015/09/18, 2015/09/19	US $ 350 per day (1750 $)	1,750
Russia	Jangheung Bay	Echosounder	2016/5/16, 2016/5/17	US $ 1500 ($ 750 per day)	1,500
Total					6,400

Annex 3

Provisional table of contents of the feasibility study towards assessment of seagrass distribution in the NOWPAP region
(Updated on August 7, 2017)

- **Executive summary**

- **Introduction**
  - **Objectives and background**

- **Chapter 1 Data and method of the feasibility study**
  - **Collection of data**
  - **Methodology of the feasibility study**
  - **Flow of the study**

- **Chapter 2 Seagrass in the NOWPAP region**
  - **Seagrass species in the NOWPAP region.**
  - **Threats to seagrass in the NOWPAP region**

- **Chapter 3 Case studies of mapping seagrass distribution by satellite images in selected sea areas in the NOWPAP region**
  - **A manual for seagrass and seaweed beds distribution mapping with satellite images**
  - **Case studies in the 2014-2015 biennium**
  - **Obstacles and limitation of using satellite images**

- **Chapter 4 Towards mapping of seagrass distribution in the entire NOWPAP region**
  - **Available satellite images**
  - **Estimation of image analysis cost**
  - **Potential collaborators**
  - **Possible funding options**

- **Summary and recommendations**
  - **Summary**
  - **Recommendations**