Report of the Study Group on *Marine Ecosystem Services*

The Study Group on *Marine Ecosystem Services* (SG-MES) met from 9:00 to 18:00 on September 23, 2017, in Vladivostok, Russia, under the Chairmanship of Dr. Shang Chen. Participants introduced themselves. Three members of the Study Group were in attendance as well as the HD Chairman and other PICES members and observers (***SG-MES Endnote 1***). SG-MES reviewed and accepted the agenda (***SG-MES Endnote 2***). While six of the Study Group members were unable to attend the meeting, they provided feedback electronically prior to the meeting. The Study Group meeting was extremely productive, with constructive discussions and sharing of information.

SG-MES was supported by the Section on *Human Dimensions of Marine Systems* (S-HD), the Human Dimensions Committee (HD) and Science Board in its attempt to address FUTURE program Objective 1 (Understanding Critical Processes in the North Pacific) and Objective 2 (Status Reports, Outlooks, Forecasts, and Engagement). Ecosystem services represent an important dimension of the third key scientific question under FUTURE Objective 1 (How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?). In addition, case studies on the assessment of ecosystem services in the North Pacific ecosystem will be added as a new section in PICES reports.

SG-MES meeting participants at PICES-2017, Vladivostok, Russia. From left: Tetsuichiro Fumamoto, Jungho Nam, Jingmei Li, Olga Lukyanova, Keith Criddle, Shang Chen, Wei Liu.

AGENDA ITEM 2

Background of SG-MES and overview of Terms of Reference

Dr. Shang Chen presented the background of SG-MES (***SG-MES Endnote 3***) and why it was proposed.

Marine ecosystem services (MES) have become not only an emerging and somewhat challenging subject in the scientific world, but also an increasingly important social issue. The United Nation's Millennium Ecosystem Assessment focuses on the change of global ecosystem status and services. The United Nations Environmental Programme (UNEP) formed the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012. IPBES' aim is to develop and use knowledge about ecosystem services and biodiversity to improve the national, regional and global ecosystem management. PICES has already contributed to these efforts but more substantial work is needed. One of PICES' strategic goals is to establish a scientific-policy integrated platform to provide sound scientific support to national and regional policy decision making processes in the North Pacific region. S-HD was established under the guidance of Science

Board in 2011 (1) to act as an integrated platform among marine science, social science and economic science and (2) to investigate the social and economic factors controlling the change of North Pacific ecosystem.

- With support from the Fishery Science Committee (FIS) and Biological Oceanography Committee (BIO), S-HD organized its first topic session on marine ecosystem services (BIO/FIS Topic Session (S5): *Marine ecosystem services and the contribution from marine ecosystems to the economy and human well-being*) at PICES-2013 (October 11–20, 2013, Nanaimo, Canada). This session also attracted support from IMBeR as a co-sponsor. Scientists shared a diversity of perspectives and case studies on MES during this session.
- In June 2013, S-HD organized a workshop on social and economic indicators in Honolulu where participants discussed marine ecosystem service issues. The workshop recognized the importance of ecosystem services in PICES' FUTURE program.
- At PICES-2015 (October 14–25, 2015, Qingdao, China), S-HD organized FIS Topic Session (S8) on "*Marine ecosystem services and economics of marine living resources*" co-sponsored by ICES.
- At PICES-2016 (November 2–13, 2016, San Diego, USA), a Study Group on *Marine Ecosystem Services* was established.

Dr. Chen reviewed the Terms of Reference of SG-MES (***SG-MES Endnote 3***) and reported that all tasks were completed. (TOR 2: The two planned workshops were combined into one because time conflicts.)

AGENDA ITEM 3

Review of MES methodologies and assessment cases

Dr. Chen gave a presentation on methodologies of MES. He briefly introduced the system of marine ecosystem services (***SG-MES Endnote 4***) and the methods of quantification and valuation of 15 ecosystem services.

Dr. Jingmei Li gave examples of two case studies of MES: one in China and one in the USA (on behalf for Dan Lew) (***SG-MES Endnote 5***).

AGENDA ITEM 4

Report on W2 (Workshop on coastal ecosystem services)

Dr. Wei Liu introduced a brief report on Workshop 2 (***SG-MES Endnote 6***) held on the afternoon of September 22. Dr. Shang Chen chaired the workshop. It attracted 13 participants. Three of five planned oral presentations were given. These presentations focused on MES, methods and cases of assessment ecosystem services and ecological loss, social behavior and people's value of marine ecosystem services. Study sites included China and Japan. The workshop generated in-depth discussion on the above issues.

AGENDA ITEM 5

Draft Working Group proposal

Dr. Chen introduced a proposal to establish a Working Group on *Marine Ecosystem Services* (WG-MES) to be parented by the HD Committee. The proposal was circulated to all members of SG-MES and HD for discussion prior to PICES-2017. The Study Group meeting was productive and dealt largely with editing the WG proposal. See ***SG-MES Endnote 7*** for the final version. The key contents of the proposal included:

- Linkages to other organizations
- Contributions to FUTURE

- Motivation and goals
- Terms of Reference
- Membership and leadership
- Timeline
- Expected outcomes/outputs

AGENDA ITEM 6

Proposal for topics session for the 2018 PICES Annual Meeting

Dr. Chen introduced a proposal for a topics session on integration of science and policy for sustainable marine ecosystem (***SG-MES Endnote 8***) for the 2018 PICES Annual Meeting which had been circulated to some members of SG-MES and HD prior to the meeting.

AGENDA ITEM 7

FUTURE SSC briefing

Dr. Chen gave a brief update on FUTURE (***SG-MES Endnote 9***) on behalf of Dr. Mitsutaku Makino (FUTURE SSC liaison to SG-MES). Upon review of the conceptual diagram of FUTURE, meeting participants agreed that it showed MES representing only a positive contribution – one way from sea to human society, and did not include the negative services, such as losses to people caused by marine disasters, *etc*. MES functions as a bridge from the sea to the human system and from the marine ecosystem to the social system. Since MES science plays a significant role in understanding the relationship between the marine ecosystem and social system, participants were unanimous agreement that WG-MES is needed to support HD and FUTURE.

AGENDA ITEM 8

Upcoming meetings on MES

Dr. Shang Chen introduced three academic international meetings on MES:

- 9th Ecosystem Services Partnerships world conference, December 11–15, 2017, Shenzhen, China;
- Natural Capital Symposium, March 19–22, 2018, Stanford University, USA;
- PICES-2018, HD Topic Session on "*Integration of science and policy for sustainable marine ecosystem services*" and business meeting, October 25–November 4, 2018, Yokohama, Japan.

SG-MES Endnote 1

SG-MES participation list

Members

Shang Chen (China, Chair)
Jungho Nam (Korea)
Wei Liu (China)

Observers

Keith R. Criddle (USA, HD Chair)
Jingmei Li (China, HD member)
Olga Lukyanova (Russia, MEQ, S-HAB)
Tetsuichiro Fumamoto (Japan)

Members unable to attend

Canada: Miriam O
China: Jie Chen, Wenbo Yang
Japan: Shion Takemura
Korea: Jong Seong Khim
USA: Dan Lew

SG-MES Endnote 2

SG-MES meeting agenda

1. Self-introductions
2. Background of SG-MES and overview of Terms of Reference
3. Review of MES methodologies and assessment cases
4. Report on W2 (Workshop on coastal ecosystem services)
5. Development of a proposal of establish a WG-MES
6. Development of a proposal for a topics session for the 2018 PICES Annual Meeting
7. FUTURE SSC briefing
8. Upcoming meetings on MES
9. Others
10. Concluding remarks

SG-MES Endnote 3

Proposal to establish a Study Group on *Marine Ecosystem Services* (SG-MES)

1. Background

Marine ecosystem services (MES) are benefits people obtain from marine ecosystems. Seas and Oceans provide us with ecological products and environmental services, such as seafood, regulation of climate, reducing storm disaster, waste purification, recreation and leisure, biodiversity maintenance, and so on. The value of MES has become not only an emerging and somewhat challenge subject in the scientific world, but is also an increasingly important social issue. MES has become a hot topic of many international meetings and organizations. United Nation (UN)'s Millennium Ecosystem Assessment focuses on the change of global ecosystem status and services. The ongoing World Ocean Assessment has urgent needs for knowledge on marine ecosystem services. The United Nations Environmental Programme (UNEP) formed the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012. The IPBES aims to develop and use knowledge about ecosystem services and biodiversity to improve the national, regional and global ecosystem management. PICES has already contributed to these efforts but more substantial work is needed.

One of PICES' strategic goals is to establish a scientific-policy integrated platform to provide sound scientific supports to national and regional policy decision making process in the Pacific region. The Section on Human Dimensions(S-HD) was formed under the PIFSC Science Board in 2011 to: (1) Act as an integrated platform among marine science, social science and economic science; and (2) Investigate the social and economic factors to control the change of North Pacific ecosystem. With support from FIS and BIO, S-HD organized the first session on marine ecosystem services on Oct 15, 2013. This session also attracted support from IMBER as co-sponsor. Scientists shared a diversity of perspectives and case studies on MES during this session. S-HD organized a workshop on social and economic indicators in Honolulu in June 2013; the participants discussed marine ecosystem service issue. That workshop recognized the importance of ecosystem services in PICES' FUTURE program. The S-HD had discusses this issue in October 2013 and submitted to SB for approval during PICES annual meeting. S-HD had organized two sessions on marine ecosystem services during PICES annual meeting. PICES Science Board has recognized the importance of marine ecosystem services. The ecosystem service issue has entered the mainstream of PICES communities and listed in the title of 2017 PICES Annual Meeting.

Therefore, S-HD proposed establishing a working group to promote the studies on science and policy of marine ecosystem services.

2. Description and Statement of Purpose

This new study group is planned for a one-year term. It aims to exchange and share the studies on MES in North Pacific waters, to promote ecosystem service science, and to suggest how consideration of MES could improve marine ecosystem management.

While the focus of SG-MES lies within the general TOR of S-HD, the work plan for S-HD is already very full. Formation of SG-MES will allow PICES to attract researchers with specific interest in MES while leaving S-HD members free to dedicate their effort to completing the current work-plan.

The SG-MES group will help meet the FUTURE program's Objective 1 (Understanding Critical Processes in the North Pacific) and 2 (Status Reports, Outlooks, Forecasts, and Engagement). The third key scientific questions under Objective 1 (How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?) are related on ecosystem services. The studies on supply and consumption of ecosystem services provide better understanding of North Pacific ecosystem status. In addition, the group will contribute to Objective 2. A next North Pacific Ecosystem Status Report is expected to include a preliminary assessment of the status of MES.

3. Terms of Reference

To provide an opportunity for greater discussion of the proposal among scientists in PICES Member counties, the study group will:

1. Review the studies on MES;
2. Convene 2 workshops, one is an Inter Sessional WS during the UNESCO/IOC/WESTPAC Conference, and one is at PICES Annual Meeting 2017. to identify MESs provided in the North Pacific waters, and the scientific tools/methodologies for analyzing them;
3. To develop the list of MESs, and the natural and social scientific tools/methodologies to analyze each MESs. Based on this list, assess the activities by PICES Expert Groups, and identify the gaps to cover all the major MESs in the North Pacific;
4. To develop the subsequent WG's terms of references and its' potential member list in consideration of wider interests of scientists in PICES member nations, including relevance to the FUTURE's mandate.

4. Suggested members of Study group

Each member country recommends 3-5 scientists with backgrounds in marine ecology, marine economics, or marine management to be the members. Two members will serve as co-chairs. One from the west of North Pacific (Dr. Shang Sunny Chen, a S-HD member from China), while the other from the east.

5. Possible financial support

State Oceanic Administration of China would like to provide support for this study group together with PICES, such as fund to cover meeting facilities and cover invited speakers' travel expenses etc.

6. Tentative Timeline/ Process/ Products

November 2016: Study group approval,
January 2017: Nominate/finalize membership and chairmanship,
February 2017: Initiate work by correspondence,
April 2017: Organize a workshop during UNESCO/IOC/WESTPAC Conference, in Qingdao,
October 2017: Convene a workshop during 2017 PICES annual meeting,
April 2018: Submit final report and recommendation to S-HD and Science Board.

SG-MES Endnote 4

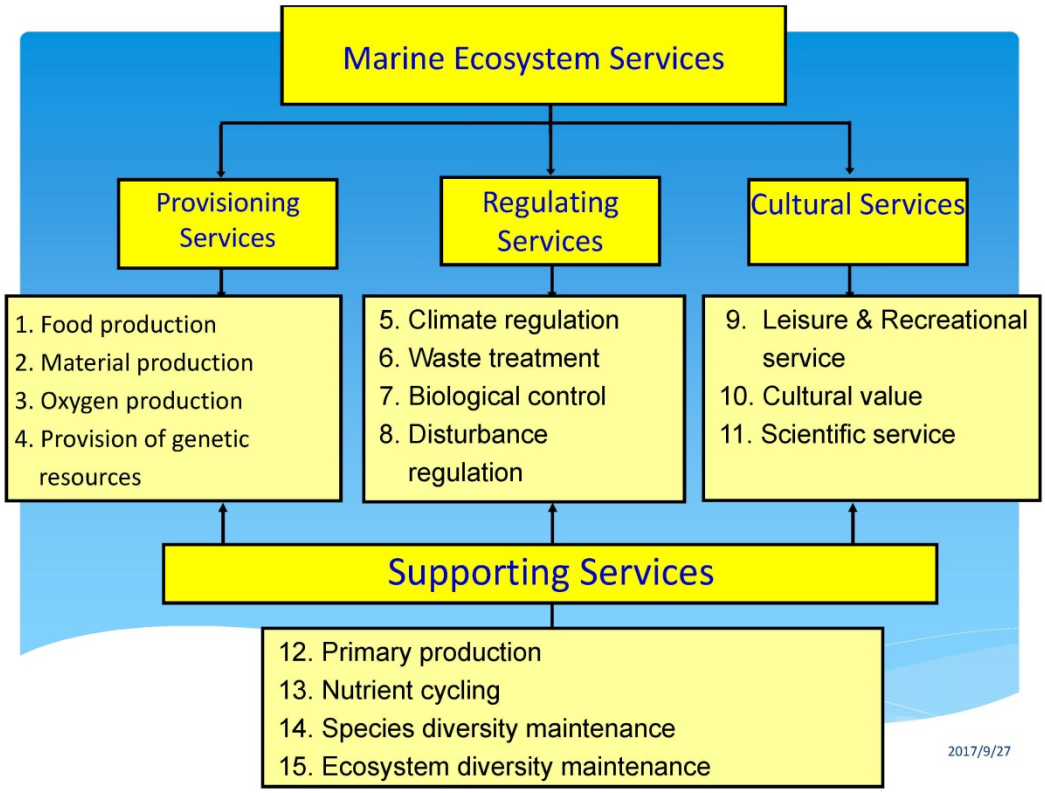

Figure 1. Marine Ecosystem Services System

SG-MES Endnote 5

Review of MES assessment cases for China

Type of marine ecosystem	Location	Area size (km^2)	Kind of ecosystem service assessed	Quantity in physical units	Value in USD	Average per km^2 in physical units (t)	Average value per km^2 in USD	Valuation method	If with spatial distribution map
Bay, shallow waters	Shandong coastal waters in Bohai Sea and Yellow Sea							TCM for LR; CVM for SD; Market method for PS,OP,	Yes
Marsh	Xiamen inter-tidal and coastal waters	0.739	OP	Oxide release	242,539	4200.27	328,200	Statistics and market method for WD, DR, PS, OP; TCM for LR; CVM for SD; Carbon market method for CR	Yes
			WD	COD treatment	155,759		210,770		
			CR	carbon dioxide absorption	186,911	1575	252,924		
			DR		904,517		1,223,974		
			LR		47,840		64,737		
			SD		211,388		286,046		
			PS		17,801		24,088		
Gravel beach		0.017	CR	carbon dioxide absorption (phytoplankton)	18	6.02	1,054		
			LR		1101		64,737		
			OP	Oxide release (phytoplankton)	10	16.05	602		
Sandy beach		12.655	OP	Oxide release (phytoplankton)	7621	16.05	602		
			CR	carbon dioxide absorption (phytoplankton)	13,336	6.02	1054		
			LR		9,145,025		722,641		
			DR		9,293,632		734,384		
			SD		3,619,906		286,046		
Mangrove		0.57	OP	Oxide release	21,453	907.6	37,638		
			WD	COD treatment	120,139	143	210,770		
			CR	carbon dioxide absorption	30,893	340.35	54,198		
			DR		697,665		1,223,974		
			LR		37,758		66,242		
			SD		163,046		28,6046		

Type of marine ecosystem	Location	Area size (km^2)	Kind of ecosystem service assessed	Quantity in physical units	Value in USD	Average per km^2 in physical units (t)	Average value per km^2 in USD	Valuation method	If with spatial distribution map
			PS		13,730		24,088		
Rock beach		1.181	OP	Oxide release (phytoplankton)	711	16.05	602		
			CR	carbon dioxide absorption (phytoplankton)	1245	6.02	1054		
			LR		76,454		64,737		
Muddy beach		81.603	PS		1,965,656		24,088		
			OP	Oxide release (phytoplankton)	49,141	16.05	602		
			WD	COD treatment	17,199,494	143	21,0770		
			CR	carbon dioxide absorption (phytoplankton)	85,997	6.02	1054		
			DR		39,951,968		48,9589		
			LR		5,282,702		64,737		
Coastal water		244.58	PS		4,050,374		16,561		
			OP		8,100,748		33,121		
			WD		22,092,950		90,330		
			CR		2,209,295		9,033		
			LR		16,201,496		66,242		
			SD		68,119,928		278,518		

CR – climate regulation or CO_2 sequestration; COD – chemical oxygen demand; PS – provisioning services; CVM – contingent valuation method; DR – disturbance regulation or protecting coast and storm prevention; LR – leisure and recreational activities, cultural value; OP – oxygen production; SD – species and habitat diversity; PS – provisioning services; TCM – travel cost method; WD – waste discharge or purification

Review of MES assessment cases for USA

Study source (citation)	Year of study	Type of marine ecosystem	Kind of ecosystem service assessed	Valuation method	If with spatial distribution map
Kline, J.D., and S.K. Swallow (1998) The Demand for Local Access to Coastal Recreation in Southern New England. *Coastal Management* 26(3): 177–190.	1998	Beach/coastal	LR	CVM	
Dixon, A.W., C-O Oh, and J. Draper (2012) Access to the Beach: Comparing the Economic Values of Coastal Residents and Tourists. *Journal of Travel Research*, 51(6): 742–753.	2012	Beach/coastal	LR	CVM	
Silberman, J., D.A. Gerlowski, and N.A. Williams (1992) Estimating Existence Value for Users and Nonusers of New Jersey Beaches. *Land Economics* 68(2): 225–236	1992	Beach/coastal	LR	CVM	
Matthews, Y., R. Scarpa, and D. Marsh (2017) Stability of Willingness-to-Pay for Coastal Management: A Choice Experiment Across Three Time Periods. *Ecological Economics* 138: 64–73.	2017	Beach/coastal	DR	CE	
Lindsay, B.E., J.M. Halstead, H.C. Tupper, and J.J. Vaske (1992) Factors Influencing the Willingness to Pay for Coastal Beach Protection. *Coastal Management* 20(3): 291–302.	1992	Beach/coastal	DR	CVM	
Penn, J., W. Hu, L. Cox, and L. Kozloff (2014) Resident and tourist preferences for stormwater management strategies in Oahu, Hawaii. *Ocean and Coastal Management* 98: 79–85.	2014	Beach/coastal	DR	CE	
Landry, C.E., A.G. Keeler, and W. Kriesel (2003) An Economic Evaluation of Beach Erosion Management Alternatives. *Marine Resource Economics* 18: 105–127.	2003	Beach/coastal	DR	CVM, Hedonic	
Whitehead, J.C., C.F. Dumas, J. Herstine, J. Hill, and B. Buerger (2008) Valuing Beach Access and Width with Revealed and Stated Preference Data. *Marine Resource Economics* 23: 119-135.	2008	Beach/coastal	LR and DR	TCM, contingent behavior	
Lew, D.K., and D.M. Larson (2008). Valuing a Beach Day with a Repeated Nested Logit Model of Participation, Site Choice, and Stochastic Time Value. *Marine Resource Economics* 23: 233–252.	2008	Beach/coastal	LR	TCM	
Lew, Daniel K., and Douglas M. Larson (2005). Valuing Recreation and Amenities at San Diego County Beaches. *Coastal Management* 33(1): 71–86.	2005	Beach/coastal	LR	TCM	
Huang, J-C., P.J. Poor, and M.Q. Zhao (2007) Economic Valuation of Beach Erosion Control. *Marine Resource Economics* 22: 221–238.	2007	Beach/coastal	DR	Variant of CE	
Loomis, J.B., and L. Santiago (2013) Economic Valuation of Beach Quality Improvements: Comparing Incremental Attribute Values Estimated from Two Stated Preference Valuation Methods. *Coastal Management* 41(1): 75–86.	2013	Beach/coastal	LR	CVM and CE	
Parson, G.R., Z. Chen, M.K. Hidrue, N. Standing, and J. Lilley (2013) Valuing Beach Width for Recreational Use: Combining Revealed and Stated Preference Data. *Marine Resource Economics* 28: 221–241.	2013	Beach/coastal	LR	TCM, contingent behavior	
Landry, C.E., and H. Liu (2009) A Semi-Parametric Estimator for Revealed and Stated	2009	Beach/coastal	LR	TCM, contingent	

Study source (citation)	Year of study	Type of marine ecosystem	Kind of ecosystem service assessed	Valuation method	If with spatial distribution map
Preference Data -- An Application to Recreational Beach Visitation. *Journal of Environmental Economics and Management* 57: 205–218.				behavior	
Penn, J., W. Hu, L. Cox, and L. Kozloff (2015) Values for Recreational Water Quality in Oahu, Hawaii. *Marine Resource Economics* 31(1): 47–62.	2015	Beach/coastal	LR	CE	
Peng, M., and K.L.L. Oleson (2017) Beach Recreationists' Willingness to Pay and Economic Implications of Coastal Water Quality Problems in Hawaii. *Ecological Economics* 136: 41–52.	2017	Beach/coastal	LR	CE	
McConnell, K.E. (1977) Congestion and Willingness-to-Pay: A Study of Beach Use. *Land Economics* 53: 185–95.	1977	Beach/coastal	LR	TCM	
Parsons, G.R., D.M. Massey, and T. Tomasi (1999) Familiar and Favorite Sites in a Random Utility Model of Beach Recreation. *Marine Resource Economics* 14: 299–315.	1999	Beach/coastal	LR	TCM	
Silberman, J., and M. Klock (1988) The Recreation Benefits of Beach Renourishment. *Ocean and Shoreline Management* 11: 73–80.	1988	Beach/coastal	LR	TCM	
Deacon, R.T., and C.D. Kolstad (2004) Valuing Beach Recreation Lost in Environmental Accidents. *Journal of Water Resources Planning and Management* 126(6):374–81.	2004	Beach/coastal	LR	TCM	
Paudel, K.P., R.H. Caffey, and N. Devkota (2011) An Evaluation of Factors Affecting the Choice of Coastal Recreational Activities. *Journal of Agricultural and Applied Economics* 43(2): 167–179	2011	Beach/coastal	LR	TCM	
Gopalakrishnan, S., M.D. Smith, J.M. Slott, and A.B. Murray (2011) The Value of Disappearing Beaches: A Hedonic pricing model with endogenous beach width. Journal of *Environmental Economics and Management* 61: 297–310.	2011	Beach/coastal	DR	Hedonic	
Landry, C.E., and P. Hindsley (2011) Valuing Beach Quality with Hedonic Property Models. Land Economics 87(1): 92–108.	2011	Beach/coastal	DR	Hedonic	
Lew, D.K., D.F. Layton, and R.D. Rowe (2010). "Valuing Enhancements to Endangered Species Protection Under Alternative Baseline Futures: The Case of the Steller Sea Lion." Marine Resource Economics 25(2): 133–154.	2010		SD	CE	
Lew, D.K., and K. Wallmo (2011). External Tests of Embedding and Scope in Stated Preference Choice Experiments: An Application to Endangered Species Valuation. *Environmental and Resource Economics* 48(1): 1–23.	2011		SD	CE	
Wallmo, K., and D.K. Lew (2011). Valuing Improvements to Threatened and Endangered Marine Species: An Application of Stated Preference Choice Experiments. *Journal of Environmental Management* 92: 1793–1801.	2011		SD	CE	
Wallmo, K., and D.K. Lew (2012). "Public Values for Recovering and Downlisting Threatened and Endangered Marine Species." Conservation Biology 26(5): 830–839.	2012		SD	CE	
Johnston, R., D. Jarvis, K. Wallmo, and D.K. Lew (2015). Characterizing Large Scale Spatial	2015		SD	CE	

Study source (citation)	Year of study	Type of marine ecosystem	Kind of ecosystem service assessed	Valuation method	If with spatial distribution map
Pattern in Nonuse Willingness to Pay: An Application to Threatened and Endangered Marine Species. *Land Economics* 91(4): 739–761.					
Wallmo, K., and D.K. Lew (2015). Public Preferences for Endangered Species Recovery: An Examination of Geospatial Scale and Non-Market Values. *Frontiers in Marine Science* 2: 55.	2015		SD	CE	
Wallmo, K., and D.K. Lew (2016) A Comparison of Regional and National Values for Recovering Threatened and Endangered Marine Species in the United States. *Journal of Environmental Management* 179: 38–46	2016		SD	CE	
Lew, D.K., and K. Wallmo (2017) Temporal Stability of Stated Preferences for Endangered Species Protection in Choice Experiments. *Ecological Economics* 131: 87–97.	2017		SD	CE	
Solomon, B.D., C.M. Corey-Luse, and K.E. Halvorsen (2004) The Florida Manatee and Eco-tourism: Toward a Safe Minimum Standard. *Ecological Economics* 50: 101–115.	2004		SD	CVM	
Larson, D.M., S.L. Shaikh, and D.F. Layton (2004) Revealing Preferences for Leisure Time from Stated Preferences. *American Journal of Agricultural Economics* 86: 307–320.	2004		SD	TCM	
Loomis, J.B., S. Yorizane, and D.M. Larson (2000) Testing Significance of Multi-Destination and Multi-Purpose Trip Effects in a Travel Cost Method Demand Model for Whale Watching Trips. *Agricultural and Resource Economics Review* 29(2): 183–191.	2000		LR	TCM	
Lew, D.K. (2015) "Willingness to Pay for Threatened and Endangered Marine Species: A Review of the Literature and Prospects for Policy Use." *Frontiers in Marine Science* 2: 96.	2015		SD	CVM, CE	Review article
Loomis, J.B., and D.M. Larson (1994) Total Economic Values of Increasing Gray Whale Populations: Results from a Contingent Valuation Survey of Visitors and Households. *Marine Resource Economics* 9: 275–286.	1994		SD	CVM	
Giraud, K., B. Turcin, J. Loomis, and J. Cooper (2002) Economic Benefit of the Protection Program for the Steller Sea Lion. *Marine Policy* 26: 451–458.	2002		SD	CVM	
Whitehead, J. (1993) Total Economic Values for Coastal and Marine Wildlife: Specification, Validity, and Valuation Issues. *Marine Resource Economics* 8: 119-132.	1993		SD	CVM	
Loomis, J.B., and D.S. White (1996) Economic Benefits of Rare and Endangered Species: Summary and Meta-Analysis. *Ecological Economics* 18: 197–206.	1996		SD	CVM	Review article
Richard, L., and J. Loomis (2009) The Total Economic Value of Threatened, Endangered, and Rare Species: An Updated Meta-Analysis. *Ecological Economics* 68: 1535–1548.	2009		SD	CVM, CE	Review article
Wallmo, K., and R. Kosaska (2017) Using Choice Models to Inform Large Marine Protected Area Design. *Marine Policy* 83: 111–117.	2017		SD, LR, and TES?	CE	MPA
Wallmo, K., and S. Edwards (2008) Estimating nonmarket values for marine protected areas: a latent class modeling approach. *Marine Resource Economics* 23: 301–323.	2008		SD, LR, and TES?	CE	MPA
Kasperski, S., and R. Wieland (2009) When is it Optimal to Delay Harvesting? The Role of	2009		PS	Production	

Study source (citation)	Year of study	Type of marine ecosystem	Kind of ecosystem service assessed	Valuation method	If with spatial distribution map
Ecological Services in the Northern Chesapeake Bay Oyster Fishery. *Marine Resource Economics* 24: 361–385.				function model (bioeconomic model)	
Mistaean, J.A., I.E. Strand, and D. Lipton (2003) Effects of Environmental Stress on Blue Crab (*Callinectes sapidus*) Harvests in the Chesapeake Bay Tributaries. *Estuaries* 26(2A): 316–322.	2003		PS	Production function model (bioeconomic model)	
Lipton, D. (2004) The Value of Improved Water Quality on Chesapeake Bay Boaters. *Marine Resource Economics* 19: 265–270.	2004		LR	CVM	
Petrolis, D.R., M.G. Interis, J. Hwang (2014) America's Wetland? A National Survey of Willingness to Pay for Restoration of Louisiana's Coastal Wetlands. *Marine Resource Economics* 29(1): 17–37.	2014		PS, DR, and LR	CE	
Kahn, J.R., and W.M. Kemp (1985) Economic Losses Associated with the Degradation of an Ecosystem: The Case of Submerged Aquatic Vegetation in Chesapeake Bay. *Journal of Environmental Economics and Management* 12: 246–263.	1985			Damage function approach	
Kahn, J.R. (1987) Measuring the Economic Damages Associated with Terrestrial Pollution on Marine Ecosystems. *Marine Resource Economics* 4: 193–209.	1987			Production function model (bioeconomic model)	
Johnston, R.J., M.H. Ranson, E.Y. Besedin, and E.C. Helm (2006) What Determines Willingness to Pay per Fish? A Meta-Analysis of Recreational Fishing Values. *Marine Resource Economics* 21: 1-32.	2006		LR	Multiple	Review article
Anderson, L.E., and S.T. Lee (2013) Untangling the Recreational Value of Wild and Hatchery Salmon. *Marine Resource Economics* 28: 175–197.	2013		LR	CE	
Carter, D.W., and C. Liese (2012) The Economic Value of Catching and Keeping or Releasing Saltwater Sport Fish in the Southeast USA. *North American Journal of Fisheries Management* 32(4): 613-625.	2012		LR	CE	
Carter, D.W., and C. Liese (2010) Hedonic Valuation of Sportfishing Harvest. *Marine Resource Economics* 25: 391–407.	2010		LR	Hedonic	
Lew, D.K., and D.M. Larson (2015). Stated Preferences for Size and Bag Limits of Alaska Charter Boat Anglers. *Marine Policy* 61: 66–76.	2015		LR	CE	
Lew, D.K., and D.M. Larson (2014). Is a Fish in Hand Worth Two in the Sea? Evidence from a Stated Preference Study. *Fisheries Research* 157: 124–135.	2014		LR	CE	
Larson, D.M., and D.K. Lew (2013). How Do Harvest Rates Affect Angler Trip Patterns? *Marine Resource Economics* 28(2): 155–173.	2013		LR	TCM	

Study source (citation)	Year of study	Type of marine ecosystem	Kind of ecosystem service assessed	Valuation method	If with spatial distribution map
Lew, D.K., and D.M. Larson (2012). Economic Values for Saltwater Sport Fishing in Alaska: A Stated Preference Analysis. *North American Journal of Fisheries Management* 32(4): 745–759.	2012		LR	CE	
Lew, D.K., and D.M. Larson (2011). A Repeated Mixed Logit Approach to Valuing a Local Sport Fishery: The Case of Southeast Alaska Salmon. *Land Economics* 87(4): 712–729.	2011		LR	TCM	
Huppert, D.D. (1989) Measuring the Value of Fish to Anglers: Application to Central California Anadromous Species. *Marine Resource Economics* 6(2): 89–107.	1989		LR	TCM, CVM	
Shideler, G.S., D.W. Carter, C. Liese, and J.E. Serafy (2015) Lifting the Goliath Grouper Harvest Ban: Angler Perspectives and Willingness to Pay. *Fisheries Research* 161: 156–165.	2015		LR	CVM	
Whitehead, J.C., C.F. Dumas, C.E. Landry, and J. Herstine (2011) Valuing Bag Limits in the North Carolina Charter Boat Fishery with Combined Revealed and Stated Preference Data. *Marine Resource Economics* 26: 233–241.	2011		LR	TCM, contingent behavior	

CE – choice of experiment; CVM – contingent valuation method; DR – disturbance regulation or protecting coast and storm prevention; LR – leisure and recreational activities, cultural value; PS – provisioning services; SD – species and habitat diversity; TES – total ecosystem service; TCM – travel cost method

SG-MES Endnote 6

Report on Workshop 2 at PICES-2017

Coastal ecosystem services in the North Pacific and analytical tools/methodologies for their assessment

Convenors:
Shang Chen (China); Mitsutaku Makino (Japan) (unable to attend)

Invited Speaker:
Benrong Peng (University of Xiamen, China) (unable to attend)

Background

Coastal ecosystem services are the benefits people obtain from the coastal ecosystem. These services include seafood, regulation of climate, reduction of storm impacts, waste assimilation, recreation and leisure, and biodiversity maintenance. The identification, quantification, and valuation of ecosystem services and understanding the impacts of human activities and climate change on ecosystem services are key scientific questions. The ecosystem services-based approach to marine ecosystem management is a new approach meant, in part, to enhance human well-being. The goals of this workshop were: (1) to present research that enhances understanding of the interactions between human activities and ecosystem services; (2) to provide a venue for natural scientists and social scientists to exchange results from research on identification, assessment, management and investment of ecosystem services, and (3) to provide Study Group on Marine Ecosystem Services (SG-MES) members and scientists around the North Pacific an opportunity to discuss collaboration on scientific projects within the North Pacific Ocean. This workshop made an important contribution to a greater understanding of the status of human dimensions of the North Pacific ecosystem and filled some gaps to achieve the objectives outlined by the FUTURE integrative program.

Summary of presentations

This ½-day workshop arranged 5 high quality presentations and was chaired by Dr. Shang Chen. A total 14 people, including Dr. Hiroaki Saito (Science Board Chair) and Dr. Keith Criddle (HD Chair) attended this workshop. Three oral presentations were presented followed by in-depth discussion.

Professor Jingmei Li made a report on the assessment of ecological damages from land reclamation. She pointed out the increasing amount of land reclamation in China and its negative impact on resources and marine ecosystems. She noted that assessing marginal ecological damage costs incorporated into management will prevent operators from conducting reclamation. There were two methods to choose from to evaluate environmental costs. Then, based on the choice of experiment method, the loss of ecological benefits caused by wetland reclamation in Jiaozhou Bay was analyzed. Results showed that the change of wetland area is the first most important concern of local residents, followed by improvement in water quality. Based on these concerns, the government should make a proper restoration policy in which enlarging the wetland area should be the key priority.

Dr. Shang Chen presented his study on marine ecological services capital assessments. First, he introduced some basic concepts on marine ecological capital (MEC), such as MEC value and Marine Ecosystem Services (MES). Then he described his assessment methods for evaluating standing stock of marine living resources and marine ecosystem services which have been issued as a national standard in China. The Chinese coastal ecosystem provided 1,034 billion CNY of ecosystem services in 2008, which supported 1,740 billion CNY of

marine industrial products. His studies showed that the service value decreased from onshore to offshore, with high value in maricultured and tourism areas, and that service value depended highly on utilization methods. Finally, the MES theory can be used as one of the principles to make functional zoning and marine development planning, as assessment indicators of marine management effectiveness and blue economic policy, as a baseline of eco-compensation or payment for ecosystem service policy.

Kazumi Wakita talked about what influences people's value of marine ecosystem services and their motivation for conservation. Dr. Wakita's study took an interdisciplinary approach that combined environmental economics and social psychology in examining relationships between people's value of marine ecosystem services and factors which influence their value, using responses to a questionnaire from 945 residents in Japan. The analysis reveals that the groups of respondents with a higher willingness to pay (WTP) to conserve marine ecosystem services have higher public spirit and stronger connections with other people and invisible things such as spirits. On the other hand, the groups of free riders who have no WTP to conserve marine ecosystem services have lower public spirit and weaker connections with others, both humans and non-humans. The respondents' degree of support for the theory of global warming caused by an increase in carbon dioxide and that for forecasting the increase of carbon dioxide did not seem to influence their WTP. Considering that the scenario provided to the respondents was about the status of marine ecosystem services in the next 100 years, the respondents' WTP can interpreted as representing a kind of altruism.

List of papers

Oral presentations

Valuing the loss of ecological benefits of wetland reclamation in Jiaozhou Bay based on choice experiments
Jingmei Li, Qi Chen

Marine ecosystem services assessment methods
Shang Chen, Wei Liu, Tao Xia and Linghua Hao

What influences people's value of marine ecosystem services: A case study of Japan
Kazumi Wakita, Hisashi Kurokura, Taro Oishi, Zhonghua Shen, and Ken Furuya

List of Participants

Shang Chen (China)
Jingmei Li (China)
Wei Liu (China)
Guangshui Na (China)
Kazumi Wakita (Japan)
Taichi Yonezawa (Japan)
Sukgeun Jung (Korea)
Olga Lukyanova (Russia)
Kristina Markevich (Russia)
Alena Moskovtseva (Russia)
Sergey Semenkov (Russia)
Anna Shvedova (Russia)
Keith R. Criddle (USA)
Hiroaki Saito (Science Board Chair)

SG-MES Endnote 7

Proposal to Establish a Working Group on *Marine Ecosystem Services*

1. Proposed expert group type and name

Working Group on *Marine Ecosystem Services* (WG-MES).

2. Reporting to

The WG-MES would be the first working group sponsored by the Human Dimensions Committee (HD).

3. Term

The term for this working group is expected to be 3 years.

4. Linkages to other organizations

The WG-MES will be led by PICES and will focus on the MES issues in the North Pacific Ocean. However, WG-MES could benefit from engagement with other international organizations and programs that include MES expertise. It is anticipated that WG-MES activities will attract participation from within PICES and from outside.

IMBeR has expressed strong interest in the WG-MES if approved by PICES. If PICES agrees, WG-MES would like to accept IMBeR's support, such as co-sponsorship of topic sessions, workshops, and intersessional meetings, sending group members, observers and/or sending experts to participate in WG-MES meetings. If PICES agrees, WG-MES would like to seek the similar collaboration with ICES because they have many experts in MES.

5. Contributions to FUTURE

The WG-MES will help meet the FUTURE program Objective 1 (Understanding Critical Processes in the North Pacific) and Objective 2 (Status Reports, Outlooks, Forecasts, and Engagement). Ecosystem services represent an important dimension of the third key scientific question under FUTURE Objective 1 (How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?). In addition, case studies on the assessment of ecosystem services in the North Pacific ecosystem will be added as a new section in PICES' Reports.

6. Motivation and Goals

Marine ecosystems provide direct or indirect benefits to people. Ocean ecosystems provide human populations with ecological goods and services, such as seafood, climate regulation and air quality maintenance, storm damage prevention, waste purification, recreation and leisure opportunities, and biodiversity maintenance, among others. The accounting for anthropogenic values of marine ecosystem services (MES) in policy and management decisions has become an emergent issue recognized as critical from a social, economic, and cultural perspective, but also one that poses challenges both from a scientific and policy perspective. As a result, MES has become a hot topic of many international meetings and organizations. The United Nation (UN)'s Millennium Ecosystem Assessment focuses on the change of global ecosystem services' status and trends. Similarly, the ongoing World Ocean Assessment expresses urgent need for knowledge on marine ecosystem services. The United Nations Environmental Programme (UNEP) established the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012. The IPBES aims to develop and use knowledge about ecosystem services and biodiversity to improve ecosystem-based management at national, regional, and global scales. PICES has already contributed to these efforts but more substantial work is needed.

Since 1992, PICES as a scientific organization has become more important in promoting marine science and better understanding of the marine environment in the North Pacific, as well as in the world. One of PICES' strategic goals is to establish a scientific-policy integrated platform to provide sound scientific support to national and regional policy decision-making processes. To meet the demand of members from PICES, The Human Dimensions Committee (HD) was established under the PICES Science Board (SB) in November 2016. HD's area of responsibility is to promote and coordinate interdisciplinary research that leads to increased understanding of the relationship between North Pacific marine ecosystems and the people, communities, and economies that are part of those systems and rely on the resources and services they provide. In November, 2016, a Study Group on MES (SG-MES) was established by the SB to promote and coordinate research to improve MES assessment methodologies and to mainstream the MES in marine management and policy. SG-MES was also charged with developing the terms of reference for a working group that would continue these efforts.

HD and S HD have organized several topic sessions/workshops on marine ecosystem services during PICES annual meetings. One of them also attracted support from IMBER as a co-sponsor. Consequently, the importance of ecosystem services in PICES' FUTURE program was recognized, so much so that "Ecosystem Services" was prominent in the title of the 2017 PICES annual meeting, "Environmental Changes in the North Pacific and Impacts on Biological Resources and Ecosystem Services."

Based on the SG-MES's one-year work, HD proposes the establishment of a working group (WG-MES) to promote studies related to science and policy of marine ecosystem services. WG-MES will facilitate exchange of information and share the experiences of case studies on MES in North Pacific waters in order to promote ecosystem service science and improve the consideration of MES in decision making related to marine integrated management. There are differences in methodology and practice of MES studies among North Pacific countries. Therefore, one of the goals of the WG-MES is to establish a set of regional technical guidelines on MES assessment and the integration and utilization of MES information in the policy process, as well as to provide technical support to national and regional bodies engaged in these activities. Formation of the WG-MES will allow PICES to attract more researchers with specific interest in MES.

7. Terms of Reference

1. Review MES studies of North Pacific marine ecosystems, identifying the scientific tools and methodologies employed, and the role these studies have played in policy analyses, management, or natural resource damage assessment.
2. Develop a typology of marine ecosystem services, tools and methodologies (e.g., environmental accounting/natural capital, non-market values, replacement cost/Natural Resource Damage Assessment, productivity change methods, etc.) that can be used to analyze marine ecosystem services, and the strengths and weaknesses of those tools and methodologies.
3. Illustrate (2) by applying two or more methods to the assessment of marine ecosystem services in identical case studies in multiple regions of the North Pacific.
4. Collaborate with WG 36 (*Common Ecosystem Reference Points*) and WG 40 (*Climate and Ecosystem Predictability*) to explore development of an indicator-based framework to study the resilience of social ecological systems and to advance integration envisioned in the FUTURE science program.
5. Complete a detailed technical report on the results of the analyses detailed in TORs (1), (2), and (3) and scoping requested in (4). The report should include practical recommendations for characterizing the status and trends of marine ecosystem services in the North Pacific. In addition, the WG will contribute articles on ecosystem services to PICES Press.

8. Proposed membership

Each member country recommends 3-5 scientists with backgrounds in marine ecology, marine economics, marine law and management to be the members.

Two members will serve as co-chairs: One from the western North Pacific (Potential Candidate: Dr. Shang Sunny Chen, HD, S-HD, SG-MES Chair, FIO, SOA, China) and the other from the eastern North Pacific (Potential Candidate: Dr. Dan Lew, SG-MES, NOAA Alaska Fisheries, USA).

Each co-sponsor is expected to recommend 2-3 scientists as the member of WG-MES to participate the WG-MES activities and finish their tasks based on the negotiation.

Proposed members

Canada:
Ms. Miriam O (SG-MES, Fisheries and Ocean Canada, miriam.O@dfo-mpo.gc.ca)

China:
Dr. Shang Chen (HD, S-HD, SG-MES Chair, FIO, SOA, China, schen@fio.org.cn
Prof. Jingmei Li(HD, Ocean Univ. of China, jingmeili66@163.com)
Prof. Bengrong Peng (Xiamen Univ., China, brpeng@xmu.edu.cn)
Dr. Wei Liu (SG-MES, FIO, SOA, China, weiliu@fio.org.cn)
Dr. Jie Chen (SG-MES, South China Sea Institute, SOA, chenjie-1984@hotmail.com)

Korea:
Dr. Jungho Nam (SG-MES, KMI, Korea, jhnam@kmi.re.kr)
Prof. Jong Seong Kim (SG-MES, School of Earth, SNU, Korea, jskocean@snu.ac.kr)

Japan:
Associate Professor Kazumi Wakita (Tokai University, Japan, kazumiw@tokai-u.jp)
Dr. Shion Takemura (SG-MES, National Research Institute of Fisheries Science, Japan, shiontakemura@affrc.go.jp)

Russia:
Dr. Olga Lukyanova(S-HD, HAB-S, MEQ, WG-31, Pacific Scientific Research Fisheries Center (TINRO-Center, Russia, olga.lukyanova@tinro-center.ru)
Professor Elena Anferova (Far Estern Federal University, Russia, anferova@mail.ru)

USA:
Dr. Dan Lew (SG-MES, Alaska Fisheries Science Center, NOAA Fisheries, USA, Dan.Lew@noaa.gov)

9. Timeline

a. October 2017: Working group approval from HD, SB, and GC.
b. January 2018: Nominate/finalize membership and chairmanship.
c. March 2018: Initiate work by correspondence
d. April or May 2018: Hold a 2-day workshop in Qingdao to develop a work plan to address the TORs, including preliminary discussion of possible case study sites and methods. Review MES studies of North Pacific marine ecosystems (TOR-1). Submit the work plan to HD for approval (***Appendix I***).
e. October 2018: Hold a 1-day business meeting and a ½-day topic session during PICES annual meeting in Yokohama. The business meeting will be used to draft a typology of marine ecosystem services, tools and methodologies that can be used to analyze marine ecosystem services, and the strengths and weaknesses of those tools and methodologies (TOR-2). Selection of case study sites and analytic methods will be

finalized during this meeting (TOR-3). The WG-MES will meet with WG-36 and WG-40 to begin exploration of synergies (TOR-4).

f. Oct 2019: f. Fall 2019: Hold a 1-day business meeting during the PICES Annual Meeting. The meeting will review progress on case studies (TOR-3). The WG-MES will meet with WG 36 and WG 40 to continue exploration of synergies (TOR-4).
g. May 2020: Hold a 3-day workshop (at an eastern Pacific location TBD) to review results of case studies (TOR-3) and to draft the technical report (TOR-5).
h. Fall 2020: Hold a 1-day business meeting during PICES annual meeting to finalize the technical report (TOR-5).

10. Possible financial support

State Oceanic Administration of China would like to support this working group's activities together with PICES, co-sponsors, and other partners, such as covering expenses related to meeting facilities, invited speakers' travel, *etc*.

11. Expected outcomes/outputs

a. A technical report on the methods used for, and case studies of, the assessment of MES, and the integration of MES information in marine management and policy analytic frameworks.
b. The ecosystem service section/paper to PICES Scientific Report series and/or PICES Press.

Appendix I

Proposal for a Workshop on
"Taking Stock of Marine Ecosystem Services in the North Pacific—exploring examples and examining methods"

April/May 2018, Qingdao, China

Convenors: Shang Chen (China, qdcs@163.com, corresponding), Daniel K. Lew (USA, Dan.Lew@noaa.gov), Kazumi Wakita (Japan, kazumiw@tokai-u.jp)

Duration: 2 days

Description: This workshop will advance understanding of the character and value of marine ecosystem services under the aegis of the PICES Working Group on Marine Ecosystem Services (WG-MES). Members of WG-MES will be invited to attend this workshop, but attendance will be open to encourage participation by local scientists. The workshop will discuss and draft a work plan to realize the TOR of WG-MES. The main task of this workshop include: (1) reviewing MES studies from the North Pacific region; (2) identifying gaps in understanding the status and trends of MES in North Pacific region; (3) developing a draft typology of marine ecosystem services and various approaches and methods for assessing those services and their value; and (4) discussing the TOR of WG-MES.

Sponsoring Committees: HD

Host Institute: First Institute of Oceanography, SOA, China

Potential Invited speakers: Kerry Turner, UK (r.k.turner@uea.ac.uk)

Potential Co-sponsors: IMBeR, NOWPAP

Publication: PICES Scientific Report from WG-MES

SG-MES Endnote 8

Proposal for a Topic Session on
"Integration of science and policy for sustainable marine ecosystem services"
at PICES-2018

Sponsoring Committee: HD

Duration: ½ day

Convenors: Shang Chen (China, qdcs@163.com, corresponding), Daniel K. Lew (USA, Dan.Lew@noaa.gov), Jungho Nam (Korea, jhnam@kmi.re.kr)

Potential Invited speakers: Dr. Pushpam Kumar (Chief, Ecosystem Services Economics Unit, Division of Environmental Policy Implementation, UNEP)

Potential Co-sponsors: IMBeR, NOWPAP

The provisioning, cultural, regulating, and supporting services are the major benefits people obtain from the coastal and marine ecosystems. The identification, quantification, valuation, and management of ecosystem services are key scientific questions that have attracted increasing concern from leading intergovernmental science organizations (such as PICES, ICES, IMBeR, UNEP/IPBES, NOWPAP) and prominent nongovernmental environmental organizations(such as WWF, TNC, ESP). The goals of this session are to: (1) provide a venue for marine scientists and social scientists to exchange results from research on identification, characterization, quantification, valuation and management of ecosystem services; and (2) provide a forum to share and discuss the integration of ecosystem service science into policy-making for marine systems. This session will continue providing strong support to the key tasks of the HD committee, contribute a greater understanding of social and economic status of the North Pacific ecosystem, and contribute to the objectives of FUTURE.

SG-MES Endnote 9

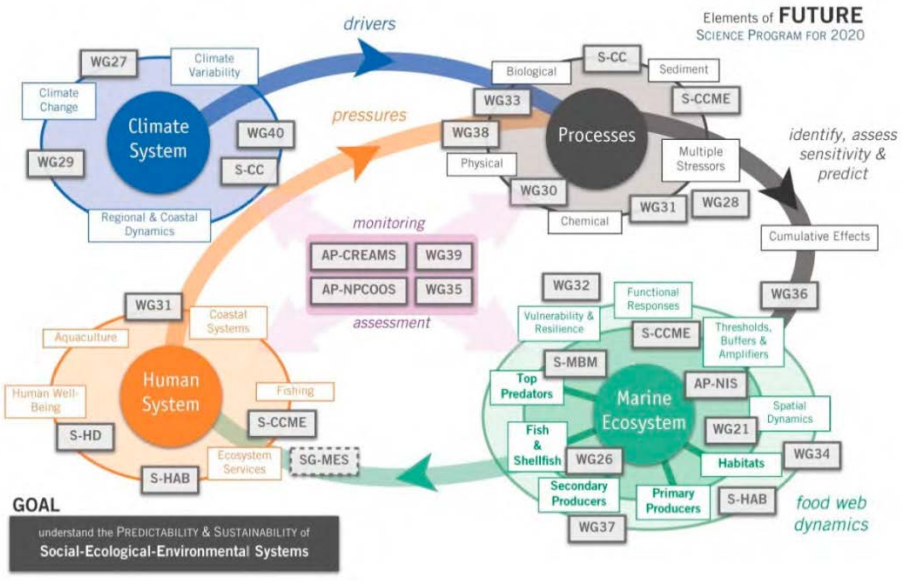

Figure 2. Elements making up FUTURE, as of 2017, showing where SG-MES (dashed outline) lies in the scheme.