Report of Working Group on *Biodiversity of Biogenic Habitats*

The meeting of the Working Group on *Biodiversity of Biogenic Habitats* (WG 32) was held over two days at the 2015 PICES Annual Meeting in Qingdao, China from 9:00–18:00 h on October 15, 2015 and 9:00–18:00 h on October 17, 2015. Over the course of two days, 14 people participated in the meeting and represented all of the six PICES member countries (*WG 32 Endnote 1*). Dr. Oleg Katugin (Russia) and Dr. Ian Perry (Canada) participated as liaisons to the FUTURE program. The meeting was co-chaired by Dr. Janelle Curtis (Canada) and Dr. Masashi Kiyota (Japan). This report summarizes discussions at the meeting on some of the Agenda Items (*WG 32 Endnote 2*).

Thursday, October 15, 2015

AGENDA ITEM 2
WG 32 Terms of Reference

Dr. Curtis (Canada) presented an overview of the history of WG 32, the rationales for its establishment and the terms of reference. WG 32 members agreed to maintain an initial focus on corals and sponges and explore opportunities to expand the work to other structure-forming taxa (*e.g.*, seagrasses, kelps, reef-forming species) in the future. Key challenges identified by WG 32 members included: limited amount of data in deep and/or international waters; data sharing and management agreements; data standards; gaps in presence/absence data held by individual researchers that have not been submitted to OBIS; and differences in sampling design and survey methods. Opportunities identified were: greater availability of data within country EEZs; 2017 research survey on Emperor Seamounts with potential to groundtruth models; potential to develop coarse models that span the North Pacific Ocean as well as regional models developed with subsets of data; linkages to the FUTURE program and other expert groups; potential to predict responses to climate change; and potential to include data from the South Pacific Ocean and other neigbouring areas.

AGENDA ITEM 3
Review and discussion of coral and sponge distribution modelling in the North Pacific Ocean

Experiences with modelling sponges in the northwest Atlantic Ocean

Dr. Anders Knudby (Canada) summarized experiences developing species distribution models for sponges in the Northwest Atlantic Ocean. Key points from his presentation related to data quality and model extrapolation:

<u>Solid data foundation is paramount to model accuracy</u>

- Specific definition of the entity modeled is crucial for interpretation (what does a 'presence' mean in terms of ID, detectability, sampling method, and spatial and temporal scale?);
- More data is better, including data from neighbouring regions (in addition to the target region). They help establish tolerance limits;
- Absence records improve model performance;
- Data from varying regions help distinguish correlation from causality – primarily because they help detect spurious correlations;
- Additional sampling can be optimized from model results:
  - Targeting unsampled regions with high presence probability,
  - Targeting regions near hypothesized upper and lower tolerance limits.

<u>Model extrapolation should be interpreted carefully</u>

- Extrapolation (geographical and environmental) reduces model performance;
- Extrapolated predictions depend strongly on model structure (models 'assume' things about structure beyond sampled environmental space. *e.g.*, GLMs and GAMs extrapolate, RF does not);

- Variable importance differs by region, even within the relatively small area we worked in (small as compared to the PICES area);
- Oceanographic regions (water masses) are likely a good basis for modelling.

Key points from the Working Group discussion included:

- Environmental variables are often variations of a few sources of data (*e.g.*, min, mean, max values of temperature at different depths or from different seasons). Often we don't know exactly which variables influence distributions, so it can be difficult to decide which variables to include/exclude. Mean variable values often fell out of model when min and max variables were important.
- Relationships to environmental variables may not be stable over space or time. Quantifying variability over time requires multiple sampling events.
- Water masses are likely a good basis for modelling; variable importance differs by region.
- For sponge models, depth, slope, summer and fall sea surface Chl-*a* min and max, max bottom temp, min bottom salinity, and min and max bottom current were all influential of model performance. The distribution of other species may also correlate with sponge distributions (*e.g.*, pollock).
- Modelling of sponges suggests that transferability declines with distance.
- Calibration from larger region often improves model performance – *i.e*., including data from neighbouring region may improve fit – but including data from whole area works not as well. In other words, including data from neighbouring regions can boost predictive accuracy of local models.
- Data from varying regions may help distinguish correlation from causality (*e.g.*, tolerance limits or empirical relationships within sampling area).
- Need to understand what a presence or absence observation means, *e.g.*, weight-based sponge ground threshold vs observed occurrence on ROV transect vs no bycatch in trawl survey.
- Absence records improve model performance.
- Use extrapolated predictions to target areas near hypothesized upper and lower tolerance limits; and to prioritize surveys (*e.g*., on areas of high probability P).
- Model extrapolation should be interpreted carefully: reduces model performance, predictions depend on model structure (*e.g*., tree-based model, assumes values that are beyond what are sampled are similar to values above or below threshold whereas Maxent will typically have pseudo-absences beyond range of values – less of an issue. Random Forest approach has interesting properties for extrapolation.
- Bias could be introduced by differences in sampling protocols/designs.
- Longevity of modelled species could be used to inform decisions on the use or exclusion of data from different time periods.
- Depth may be an important variable due to correlation with ecologically relevant variables, but also might be because it is measured more accurately. One might hypothesize that models that include depth may not extrapolate as well.

Overview of global and regional scale deep-sea modelling of corals

Dr. John Guinotte (USA) presented an overview of global and regional scale deep-sea habitat suitability efforts relevant to the North Pacific Ocean, specifically of global predictive habitat model results (derived from Maxent presence-only models) currently available for scleractinian reef-forming deep-sea corals (Davies and Guinotte 2011) and octocorals (Yesson *et al*. 2012) in the North Pacific Ocean. These model results were used to help guide the CBD EBSA identification/regional workshop process. He highlighted that significant improvements could be made in the region by incorporating new coral presence and absence information from PICES partner countries. The environmental, chemical, and physical database used to produce these models includes ~40 variables for the seafloor (global extent at 1 km × 1 km resolution). These data are publically available and could be used in any future modelling efforts for the North Pacific. Methods behind database development and accuracy assessment can be found in Davies and Guinotte (2011).

He also provided an overview of GAM (presence–absence) model results available from NOAA-NMFS for the Aleutian Islands (Rooper *et al*. 2014), Gulf of Alaska (Rooper *et al*., in prep.), and Eastern Bering Sea (Rooper, in prep). Taxa included in these analyses include sponges, corals, sea whips on a 100 m × 100 m grid. Probability of presence, density, and height were modeled for most taxa.

Dr. Guinotte presented an overview of Maxent modeling effort for deep-sea coral taxa conducted in 2013 that encompasses the entire U.S. EEZ around Alaska and the extent of Canadas EEZ off BC (Guinotte and Davies 2013). Spatial resolution of model results and seafloor database is 700 m × 700 m, derived from a custom bathymetry. Taxa are modeled to Suborder (Alcyoniina, Calcaxonia, Filifera, Holaxonia, Scleraxonia, Stonifera) and Order (Antipatharia and Scleractinia). He also presented an overview of Maxent modeling effort for deep-sea coral taxa conducted in 2014 that encompasses the entire U.S. EEZ around Washington, Oregon, and California (Guinotte and Davies 2014). Spatial resolution of model results and seafloor database is 500 m × 500 m, derived from a custom bathymetry. Taxa are modeled to Suborder (Alcyoniina, Calcaxonia, Holaxonia, Scleraxonia) and Order (Antipatharia and Scleractinia). These models did not include fisheries bycatch presence records. Due to a strong sampling bias issue regarding presence records in Monterey Canyon (MBARI), a cross validation/thresholding approach was used to identify high probability habitat in the region.

Drawing on experiences in the South Pacific Ocean, Dr. Guinotte presented an overview of 3-year joint project lead by NIWA to predict VME habitat within New Zealand's EEZ and the SPRFMO Competence Area. Phase I of this project used Maxent (presence only) and Boosted Regression Trees (presence only) to predict habitat for 10 key VME taxa. SPRFMO has defined a number of benthic invertebrate taxa that are regarded as primary indicators of potential VME habitat.

1. Phylum Porifera - Sponges
2. Phylum Cnidaria, Order Actiniaria – Anemones
3. Phylum Cnidaria, Order Alcyonacea – Soft corals
4. Phylum Cnidaria, Order Gorgonacea – Sea fans
5. Phylum Cnidaria, Order Pennatulacea – Sea pens
6. Phylum Cnidaria, Order Scleractinia – Stony corals
7. Phylum Cnidaria, Order Antipatharia – Black corals
8. Phylum Cnidaria Family Stylasteridae – Hydrocorals
9. Phylum Echinodermata, Class Crinoidea – Sea lilies
10. Phylum Echinodermata, Order Brisingida – Armless stars

A field cruise was conducted in 2014 to the Louisville Ridge seamounts to assess model performance and to help determine which methods were superior. Deep-sea coral taxa were the focus. Details of model assessment, accuracy, and model/data limitations can be found in Anderson *et al*. (submitted). Key point: the accuracy of global bathymetry datasets (*e.g*., SRTM30) in areas where very few soundings exist can be highly inaccurate. Differences of > 1000 m were documented between actual depth (measured by multibeam) and SRTM30 depths (the depths upon which model results and seafloor database were based).

Finally, Dr. Guinotte presented an overview of integration of predictive deep sea coral model results (Davies and Guinotte 2011) with projected changes in seafloor temperature and carbonate chemistry (ocean acidification) for Southern Australia. Details can be found in Thresher *et al*. (2015). The combination of increasing temperature and decreasing saturation state will likely cause the demise of deep-sea reefs off Southern Australia by 2100. Australian resource managers were convened in 2013 to discuss management options in light of this. All options were on the table, including genetic engineering, buffering with carbonates, translocation of corals and many others. The only realistic management option was determined to be to restrict benthic impacts and increase protection in the high seas/other EEZs where reefs will remain viable.

In his concluding remarks Dr. Guinotte stated that: 40 seafloor variables will be made publically available early 2016 (global, 1km). They are available upon request now, but will be served via the web in early 2016. UNEP-WCMC is in the process of updating their global cold-water coral database. Guinotte is helping them with this update and requested coral records from PICES member states. Dr. Les Watling may have records of 30 new coral species from the Hawaiian Ridge, in addition to all records documented in Watling *et al*. (2011) *Biology of Deep-Water Octocorals.* There will be a 2017 cruise on the R/V *Falkor* (SOI) to the Emperor seamounts to document bathyal biogeography and collect deep-sea corals. Dr. Watling is the PI and has agreed to help in field validation efforts of predictive habitat models that might be developed between now and 2017.

Partial list of available seafloor datasets for use in models (provided to WG 32 by John Guinotte)

Native Resolution

Variable name	Filename	Extent	Units	Reference
Terrain variables[1]				
Aspect	aspect	Full	Degree	Jenness (2012)
Aspect – Eastness[2,3]	eastness	Full		Wilson *et al*. (2007)
Aspect – Northness[2,4]	northness	Full		Wilson *et al*. (2007)
Bathymetry	srtm30	Full	m	Becker *et al*. (2009)
Curvature – Profile[5,6]	profilecurve	Full		Jenness (2012)
Curvature – Plan[5,7]	plancurve	Full		Jenness (2012)
Curvature – Tangential[5,8]	tangcurve	Full		Jenness (2012)
Roughness[9]	roughness	Full		Wilson *et al*. (2007)
Rugosity[5]	rugosity	Full		Jenness (2012)
Slope[5]	slope	Full	Degrees	Jenness (2012)
Terrain Ruggedness Index[9]	tpi	Full		Wilson *et al*. (2007)
Topographic Position Index[9]	tpi	Full		Wilson *et al*. (2007)
Environment variables				
Alkalinity[10]	alk_stein	Full	μmol l^{-1}	Steinacher *et al*. (2009)
Apparent oxygen utilisation[10]	woaaoxu	Full	mol O^2 m^{-3}	Garcia *et al*. (2006b)
Chlorophyll *a*[11]	modismin, modismean, modismax	Restricted	mg m^{-3}	NASA Ocean Color
Dissolved inorganic carbon[10]	dic_stein	Full	μmol l^{-1}	Steinacher *et al*. (2009)
Dissolved oxygen[10]	woadiso2	Full	ml l^{-1}	Garcia *et al*. (2006a)
Nitrate[10]	woanit	Full	μmol l^{-1}	Garcia *et al*. (2006b)
Omega aragonite[10,12]	arag_stein	Full	Ω_{ARAG}	Steinacher *et al*. (2009)
Omega aragonite[10,13]	oa	Restricted	Ω_{ARAG}	Orr *et al*. (2005)
Omega calcite[10,12]	calc_stein	Full	Ω_{ARAG}	Steinacher *et al*. (2009)
Omega calcite[10,13]	oc	Restricted	Ω_{ARAG}	Orr *et al*. (2005)
Percent oxygen saturation[10]	woapoxs	Full	% O_2^S	Garcia *et al*. (2006b)
Phosphate[10]	woaphos	Full	μmol l^{-1}	Garcia *et al*. (2006b)
Regional current velocity[14]	regfl	Restricted	m s^{-1}	Carton *et al*. (2005)
Salinity[10]	woasal	Full	pss	Boyer *et al*. (2005)
Silicate[10]	woasil	Full	μmol l^{-1}	Garcia *et al*. (2006b)
Seasonal variation index[15]	lutzsvi	Restricted		Lutz *et al*. (2007)
Temperature[10]	woatemp	Full	°C	Boyer *et al*. (2005)
Particulate organic carbon[16]	poc	Restricted	g C_{org} m^{-2} yr^{-1}	Lutz *et al*. (2007)
Vertical current velocity[17]	vertfl	Restricted	m s^{-1}	Carton *et al*. (2005)
Vertically generalized productivity model[18]	vgpmmin, vgpmmean, vgpmmax,	Restricted	mg C m^{-2} d^{-1}	Behrenfeld and Falkowski (1997)

Technical considerations for habitat modelling of sedentary benthic organisms:

Dr. Masashi Kiyota (Japan) made a presentation on technical challenges related to habitat modeling of marine benthic organisms. He explained that a habitat model (or species distribution model) is an empirical formulation of the static relationship between spatial occurrences of organisms with environmental variables. The model outputs may be affected by data properties (representativeness, independence, random sampling) and selection of study area, scale, resolution, and model types. These factors, as well as model validation and extrapolation should be considered during the modeling process in light of the purpose of model use. He also introduced a case study on the high-resolution modeling of large gorgonians in the southern Emperor Seamount area for fishery management, and indicated that the objectives and data requirements for fine scale local modeling are different from those for large scale global modeling.

Key discussion points following this presentation included:

- Empirical models based on snap shot of distribution and environmental variables can be used to help understand relationship between spatial use and niche; and to predict distributions in unsurveyed areas or under changing environment.
- May have quantitative data (counts, biomass); binomial data (Presence or absence); or occurrence data (presence only data). Presence-absence data can be converted to presence only data. In some cases, it's not clear if an absence is true or not; presence only modelling may be the second-best option, especially in data-deficient areas.
- Sources of data can include biological surveys, underwater visual survey methods (*e.g.*, drop camera, remotely operated vehicles), museum records, opportunistic records, integrated database (*e.g.*, OBIS)
- Metadata related to survey objectives, spatial extent, *etc*. may be poor leading to unknown biases and violations of assumptions, *i.e*., the data are representative, independent, and random (may be violated by repeated sampling and aggregated occurrence).
- Stitching data sources together is challenging when survey designs differ and there are concerns regarding matching resolution (*e.g*., in time, space).
- Ideally, sampling is random within the target study area. Realistically, sampling is typically biased to subareas.
- Envtal data are increasing with remote sensing, math modelling, online databases: oceanography, bathymetry, *etc*. But high resolution deep-sea data are still insufficient in most places.
- Study area, resolution, variables, data type and model structure depend on objectives and data availability. Large scale global/basin wide models are useful for screening priority areas for conservation and survey (*e.g*., EBSA workshop in Moscow – predictions of deep-sea octocorals potential habitat – extrapolated from other ocean basin) but are inadequate for fine-scale management zoning. Fine scale local models are more suited for ecological studies and conservation planning (*e.g.*, zoning; MPA network design).
- Sensitivity analyses can be used to investigate influences of data quality and model structure (*e.g*., cell size). Data extrapolation; usually used in large-scale models and future predictions; may violate model assumption and cause problems in fine-scale local modeling.
- Model types include: regression (GLM, GAM, Maxent); Profile (ENFA), Classification (BRT, RF). Ensemble modelling is also an option, although ecological/biological interpretation is more challenging.
- Species distribution modelling is an iterative process that includes model development, prediction, groundtruthing, and refinement. Model validation: separation of training and test data may be difficult in data-poor situation and result in overfitting; what is the "best" model? – depends on practical utility as well as modeling philosophy.
- The influence of model structure/method is well-explored and documented in literature. Maps differ among methods, especially if data do not span the multidimensional variable space. Different model types portray relationship between species and environmental data differently, but may have similar accuracy while differing in ecological appropriateness. Variable importance may differ among model types. Convergence lends credibility while divergence provides opportunities to better understand ecological relationships.

AGENDA ITEM 4

Review of available data

Canada

Dr. Curtis (Canada) presented an overview of the data, ongoing studies and research priorities from Canada's perspective. Canada has diverse marine ecosystems that support >150 sponge taxa and tens of cold water coral taxa in fjord, bank, trough, canyon, ridge, slope, seamount, hydrothermal vent and plains habitats. Previous studies have developed predictions for four orders of corals (Alcyonacea; Antipatharia; Pennatulacea; Scleractinia) on the continental slope (*e.g*., Finney 2010). Models of coral and sponge taxa are presently being developed for two seamounts off the west coast of Canada (Cobb Seamount and Bowie Seamount). ROV/drop camera and other fishery-independent survey data are available to contribute to databases, however, fishery-related data will need to be manipulated to conform to Canada's privacy policies. A better understanding of the distribution of habitat-forming corals and sponges would help support marine spatial planning initiatives (e.g.

marine protected area network design within Canada's EEZ; conservation of vulnerable marine ecosystems in international waters). It was noted that Canada has museum records from provincial and national museums. Darlene Smith (Canada) offered to follow up with Canadian OBIS contact and the national museum.

China

Dr. Huang Hao (China) provided information from surveys undertaken from 1975 to 2014 on the species and distribution of reef-building shallow water corals in China as listed below. He noted that most species, and thus data, were from southern China and that corals were less abundant and diverse in the North Pacific Ocean. Most research on corals has focused on shallow water ecosystems; there are few studies of deep-sea corals and these are usually associated with mineral exploration in the high seas of the Western Pacific Ocean. Forty-five coral genera occur in shallow waters; 26 are red-listed. Concerns regarding corals relate to the impacts of boat anchors, climate change, directed fisheries and typhoons. Data available on location of occurrences may be too coarse for developing SDMs. Also, China uses its own species coding system.

Number of species and distributions

Area	Species and genus
Guangdong and Guangxi provinces	21genus 45 species
FuJian province	8 genus 8 species
Hong Kong	21 genus 49 species
Tai Wan	58 genus 230 species
Hainan Island	34 genus 110 species
Paracel Islands	38 genus 127 species
Dongsha Islands	34 genus 101 species
Taiping Island	56 genus 163 species
Huangyan Island	19 genus 46 species
Spratly Islands	More than 50 genus 200 species

Species name and distribution

Specie name	South China Sea	Hainan Island	Guangdong and Guangxi province	Hong Kong	Taiwan	Fujian
Acropora palifera	+				+	
Acropora illepora	+	+	+	+	+	
Acropora yacinthus	+	+				
Acropora corymbosa	+	+	+		+	
Acropora formosa	+	+	+			
Acropora humilis	+	+	+		+	+
Acropora abrotanoides	+	+				
Acropora valida	+	+			+	
Acropora pulchra	+	+	+			
Acropora lutkeni		+				
Acropora florida	+	+				
Acropora brueggemanni	+	+				
Acropora robusta	+	+				
Acropora nasuta	+	+				
Acropora cerealis	+	+				
Acropora selago	+	+				
Acropora haimei	+	+	+			
Acropora horrida	+					
Acropora echinata	+					
Acropora rosaria	+					
Acropora granulosa	+					

Specie name	South China Sea	Hainan Island	Guangdong and Guangxi province	Hong Kong	Taiwan	Fujian
Acropora tenella	+					
Acropora aduncata	+					
Acropora cytherea	+	+	+	+		
Acropora tumida			+	+		
Acropora pruinosa			+	+		+
Montipora foliosa	+	+			+	
Montipora circumvallata		+				
Montipora efforescene	+	+				
Montipora truncata	+	+				
Montipora solanderi		+				
Montipora hispida	+	+	+			
Montipora stellata		+				
Montipora fragilis		+				
Montipora aenigmatica	+	+				
Montipora monasteriata	+	+	+			
Montipora turgescens	+	+				
Montipora venosa			+	+		
Montipora gaimardi		+				
Montipora foveaolata			+			
Montipora danae	+					
Pavona decussata	+	+	+	+		
Pavona frondifera	+	+	+		+	
Pavona cactus	+	+			+	
Pavona minuta	+				+	
Pavona varians	+	+	+			
Turbinaria undata		+	+			
Turbinaria peltata		+	+	+		+
Turbinaria stellulata			+			
Turbinaria elegans			+			
Turbinaria agaricia		+	+			
Turbinaria mesenterina			+	+		
盘状陀螺珊瑚 *Turbinaria mantonae*		+			+	
漏斗陀螺珊瑚 *Turbinaria crater*	+	+	+			
叶状陀螺珊瑚 *Turbinaria foliosa*			+		+	
绵琉蜂巢珊瑚 *Favia palauensis*	+	+				
标准蜂巢珊瑚 *Favia speciosa*	+	+	+	+	+	+
黄廯蜂巢珊瑚 *Favia favus*	+	+	+			
罗图马蜂巢珊瑚 *Favia rotumana*	+	+	+			
梳状菊花珊瑚 *Goniastrea pectinata*	+	+			+	
粗糙菊花珊瑚 *Goniastrea aspera*	+	+	+			
网状菊花珊瑚 *Goniastrea retiformis*	+	+				
少片菊花珊瑚 *Goniastrea yamanarii*		+				
深少片菊花珊瑚 *Goniastrea yamanarii profunda*	+	+				
顶枝珊瑚 *Acrhelia horrescens*	+	+			+	
圆饼珊瑚 *Cycloseris syslolites*	+					
碎双列珊瑚 *Diaseris fragilis*	+					

Specie name	South China Sea	Hainan Island	Guangdong and Guangxi province	Hong Kong	Taiwan	Fujian
福石芝珊瑚 *Heliofungia actiniformis*	+					
刺石芝珊瑚 *Fungia echinata*	+	+			+	
楯形石芝珊瑚 *Fungia scutaria*	+					
石芝珊瑚 *Fungia sp.*	+	+			+	
波莫特石芝珊瑚 *Fungia paumotensis*		+			+	
弯石芝珊瑚 *Fungia repanda*	+				+	
圆结石芝珊瑚 *Fungia danai*	+					
弗利吉亚肠珊瑚 *Leptoria phrygia*	+	+				
交替扁脑珊瑚 *Platygyra crosslandi*		+	+			
精巧扁脑珊瑚 *Platygyra daedalea*	+	+	+	+	+	
中华扁脑珊瑚 *Platygyra sinensis*	+	+	+	+		
粗突小星珊瑚 *Leptastrea bottae*	+					
紫小星珊瑚 *Leptastrea purpurrea*	+	+	+	+		
横小星珊瑚 *Leptastrea transversa*	+					+
棘星珊瑚 *Acanthastrea echinata*	+	+				
赫氏叶状珊瑚 *Lobophyllia hemprichii*	+	+				
伞房叶状珊瑚 *Lobophyllia corymbosa*	+	+				
华贵合叶珊瑚 *Symphyllia nobilis*	+	+			+	
菌状合叶珊瑚 *Symphyllia agaricia*	+	+			+	
辐射合叶珊瑚 *Symphyllia radians*	+	+			+	
巨大合叶珊瑚 *Symphyllia gigantea*		+				
多形穴孔珊瑚 *Alveopora polyformis*	+					
高穴孔珊瑚 *Alveopora excelse*	+					
不规则穴孔珊瑚 *Alveopora irregularis*					+	
丛生盔形珊瑚 *Galaxea fascicoularis*	+	+	+		+	
稀杯盔形珊瑚 *Galaxea asteata*	+	+	+	+		
疣状杯形珊瑚 *Pocillopora verrucosa*	+	+				
多曲杯形珊瑚 *Pocillopora meandrina*	+				+	
埃氏杯形珊瑚 *Pocillopora eydouxi*	+	+				
鹿角杯形珊瑚 *Pocillopora damicornis*	+	+				
西沙珊瑚 *Coeloseris mayeri*	+				+	
澄黄滨珊瑚 *Porites lutea*	+	+	+	+		+
普哥滨珊瑚 *Porites pukoensis*	+	+				
火焰滨珊瑚 *Porites (Synaraea)rus*	+	+				
扁枝滨珊瑚 *Porites andrewsi*	+	+	+			
灰黑滨珊瑚 *Porites nigrescens*	+	+				
融板滨珊瑚 *Porites matthaii*	+	+				

Specie name	South China Sea	Hainan Island	Guangdong and Guangxi province	Hong Kong	Taiwan	Fujian
地衣滨珊瑚 *Porites lichen*	+					
扁缩滨珊瑚 *Porites compressa*			+			
二异角孔珊瑚 *Goniopora duofaciata*		+	+			
斯氏角孔珊瑚 *Goniopora stutchburyi*			+	+		
细角孔珊瑚 *Goniopora gracilis*	+					
小角孔珊瑚 *Goniopora minor*	+					
深室沙珊瑚 *Psammocora profundacella*			+		+	
不等脊塍沙珊瑚 *Psammocora nierstraszi*	+					
毗邻沙珊瑚 *Psammocora contigua*	+	+	+			
血红沙珊瑚 *Psammocora haimeana*				+		
丑刺孔珊瑚 *Echinopora horrida*	+					
宝石刺孔珊瑚 *Echinopora gemmacea*	+					
薄片刺孔珊瑚 *Echinopora lamellose*	+	+				
粗糙刺叶珊瑚 *Echinophyllia aspera*		+	+	+	+	
奥芳刺叶珊瑚 *Echinophyllia orpheensis*	+				+	
撕裂尖孔珊瑚 *Oxypora lacera*	+					
滑真叶珊瑚 *Euphyllia glabrascens*	+	+				
缨真叶珊瑚 *Euphyllia fimbriata*	+	+				
壳形足柄珊瑚 *Podabacia crustacea*						
凹凸薄层珊瑚 *Leptoseris scabra*	+				+	
类菌薄层珊瑚 *Leptoseris mycetoseroides*	+					
纸薄层珊瑚 *Leptoseris papyracea*	+					
片薄层珊瑚 *Leptoseris gardineri*		+				
卷叶厚丝珊瑚 *Pachyseris involuta*	+					
标准厚丝珊瑚 *Pachyseris speciosa*	+	+			+	
皱纹厚丝珊瑚 *Pachyseris rugosa*	+	+				
泡囊珊瑚 *Plerogyra sinuosa*		+				
箭排孔珊瑚 *Seriatopora hystrix*						
吞蚀筛珊瑚 *Coscinaraea exesa*	+					
柱形筛珊瑚 *Coscinaraea columna*	+				+	
假铁星珊瑚 *Pseudosiderstrea tayamai*			+			
爱氏石珊瑚 *Lithophyllon edwardsi*			+	+	+	
壳形足柄珊瑚 *Podsbscis crustacea*		+			+	
小帽状珊瑚 *Halomitra pileus*	+					
健壮履形珊瑚 *Sandalitha robusta*	+	+			+	
多叶珊瑚 *Polyphyllia talpina*	+	+			+	
饶石珊瑚 *Herpolitha limax*	+				+	

Japan

Drs. Takeo Kurihara and Go Suzuki introduced WG 32 members to three monitoring programs of ecosystems in the Japanese EEZ:

1) Monitoring 1000 is organized by the Ministry of the Environment, Japan. This program has been monitoring about 1000 sites set in various habitats, which include coral reefs, kelp beds, and sea grass beds in shallow sea. In marine habitats quadrat samplings are mainly used. The program is to continue for 100 years but started only 10 years ago (so, needs additional 90 years). Some data of abundance of species will be downloadable together with location data.
2) Jalter (Japan Long Term Ecological Research Network). This is a framework of various monitoring programs organized by Japanese researchers/research groups, and is not as large as Monitoring 1000.
3) BISMaL (Biological Information System of Marine Life), a data system for biodiversity information, particularly in biogeographic data of marine organisms, constructed by Japan Agency for Marine Earth-Science and Technology (JAMSTEC). This dataset gives very useful information such as distribution ranges of deep-sea animals. This data set will become even more powerful if it is analyzed with J-DOSS, namely, Oceanographic Data and Information download service (Temperature, Current, Depth, Biology, Marine information around Japan). The URL is: http://www.jodc.go.jp/index.html

Key discussion points following this presentation included:

- The Fishery Agency of Japan has conducted surveys on deep-sea corals within and beyond Japanese EEZ, but sharing of the survey data is difficult due to sensitive issues such as poaching of precious corals that occurred extensively from late 2014 to early 2015.
- Even with limited coral or sponge data, WG 32 could use environmental data to develop predictions with models extrapolated from elsewhere (*e.g*., Hawaii); these predictions could be groundtruthed in the future.
- How do shallow, meso-photic, and deepwater corals differ in their adaptations to different environments and how are these likely to respond to climate change? These questions have important implications in terms of climate change refugia.
- Efforts to identify EBSAs within Japanese waters included analyses of deep-sea coral data.
- Some previous surveys since 1970s employed quadrat sampling along the Japanese coastal islands. Data include mollusks, shallow sea sponges; and environmental variables.

WG 32 recognized that it would be difficult to develop habitat modelling project for coral reefs and there would be a need to bring a collaborator on board, such as Dr. Hiroya Yamano (Japan), who is conducting future projection modelling for coral reef distribution, and is collaborating with Korean scientists. Dr. Kwang-Sik Albert Choi (Korea) agreed to contact Dr. Yamano about the potential for collaboration on WG 32 activities.

Some considerations regarding modelling of shallow water corals were discussed. A good bathymetry layer and information on xooxanthellae, light extinction, temperature, salinity, depth penetration of blue wavelength (from satellites), and water clarity data would be ideal. Models developed for shallow water corals in Australia were able to predict 90% of known reefs and identified many meso-photic populations that were not previously known. Mesophotic populations may play an important role as refugia.

Korea

Dr. Kwang-Sik Albert Choi (Korea) provided an overview of research undertaken in Korea on corals and sponges, dating back to the 1960s when species were identified and distribution information were collected. Monitoring and collection of sponges and corals is managed by the Ministry of Fisheries, with a focus on biodiversity (museum specimen collection). Of the universities in Korea having information on species identifications, depth distributions, and ranges of corals and sponges, these may be available to WG 32 members. Dr. Choi is interested in monitoring climate change using coral as indicator species. The northern limit of coral reefs is in Okinawa. Korea has warmer species due to the Kurishio Current. Korea also has the highest range of temperature increase (*e.g.*, a 10 degree increase recently), which is linked to the spread of invasive/non-indigenous species including *Alveopora japonica* (Scleractinia, shallow water species, like snowflake coral in Hawaii, with long polyps that look like anemones. While red-listed by the IUCN, it is establishing/spreading very quickly and affecting local kelp and algae. Dr. Choi's research in part focuses on understanding the spread of this species. Regular sampling stations are monitored in southern Japan and Jeju. No deepwater corals have been identified yet (only corals in < 20 m). He is examining the relationships between corals and benthic organisms. The corals have slow growth and a 15-year lifespan. Benthic gastropods and bivalves are associated with coral carpets. The switch from kelp bed to *A. japonica* likely has implications for fisheries, but these are not well-studied. The important question about *A. japonica* is about expansion, so scale is important as well as resolution of environmental data.

Russia

No report was available on the types of data, ongoing studies and research priorities from a Russian perspective.

USA

Dr. Chris Rooper presented information on coral and sponge data and studies in the U.S. Northeast Pacific Ocean. The National Marine Fisheries Service has been conducting research on coral and sponges on the U.S. west coast (2010–2013) and Alaska (2012–2014) to document the presence, distribution, biology and ecology of coral and sponge communities. Importantly, records of coral and sponge presence for the NE Pacific have been compiled into a centralized database available from the Deep Sea Coral Research and Technology Program (NOAA). These records include recent camera surveys throughout Alaska, as well as historical records from bottom trawl, longline, ROV and submersibles throughout the NE Pacific. Bycatch data recorded from the commercial fisheries is available, but of limited use. Environmental data available includes outputs from Regional Ocean Models (ROMS), tidal current predictions and observations, satellite observations of primary productivity and bathymetry from a number of sources. There have also been some small-scale intensive studies that produced multibeam maps. Models of coral and sponge distribution have been produced and validated for all regions in Alaska. Some models of coral and sponge distribution are also available for areas of the US West Coast. Ancillary data on species associations with deep-sea corals and sponges are also available for all regions.

Key discussion points following this presentation included:

- Several surveys are standardized according to grid or strata, which makes them suitable for habitat modelling studies.
- Standardized surveys provide reasonably good species ID, often to family level, as well as good density estimates and size information from camera surveys. Sponge species identification is fairly poor. Other data include CPUE for trawl surveys.
- Non-standardized data include commercial fisheries bycatch information, which tends to be less reliable in terms of taxonomy. Where observer data are used, may need to use higher level classifications to reduce uncertainties/errors associated with misidentifications. Some non-standard submersible surveys cover small areas or collect data on a few species (*e.g.*, *Primnoa*).
- NOAA maintains a Deepsea Coral and Sponge Database. Most data come from US waters and the database will be available online. People will be able to submit data with some measures to capture level of data quality/uncertainties.
- Little is known of the reproduction or dispersal patterns
- Substrate type is available on the west coast of USA but not in Alaska.
- Some seamounts occur within the U.S. EEZ, but are not fished and so they have not received the same attention in terms of standardized surveys. Some surveys have been carried out on seamounts in the Gulf of Alaska.
- NWFSC does some genetic analyses for species identification, but no efforts to ID sponges with genetic analysis.
- Puget Sound has one of best environmental datasets.
- Developing models for a full basin, with estimates of error associated with them, should be considered; within basin, regional models should be developed where there are areas with better data.
- Understanding where you don't have great performance could be valuable outcome – in terms of prioritizing future surveys.

- Image data puts you in a strong position to look at species-habitat associations (as opposed to trawl data) *i.e*., ToR 3 (see [WG 32 webpage]).

Members noted that there may be additional U.S. records from state agencies that are not already in NOAA's database. Dr. Rooper offered to look into this. Dr. Guinotte noted that MBARI also has records and will follow up on their availability.

AGENDA ITEMS 5 AND 6

Identify scientific research questions of mutual interest for WG 32 members and linkages to FUTURE

WG 32 members discussed a number of scientific questions that would address its terms of reference and link WG 32 activities to FUTURE themes, while focusing the group's activities on one or more research questions of mutual interest that span the broad range of ecosystems and life histories characteristic of coral and sponge taxa in the North Pacific Ocean.

The activities of WG 32 could be linked to all three of the FUTURE themes, which were presented by Dr. Ian Perry (Canada):

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?
3. How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?

General research interests common to multiple PICES member countries included:

- Development of general tools for spatial management that could be applied to a broad range of structure-forming species, including seagrasses, kelps, corals and sponges (*e.g*., linking SDM to planning software like Zonation or Marxan);
- Development of usable species distribution models for coral and sponge taxa that could be applied in management contexts, *e.g*., maps of known or hypothesized vulnerable areas;
- Refinement of existing models with improved data: over-prediction of SDM models can be improved with better species and environmental data;
- Comparison of factors that influence the distributions of shallow, meso-photic, and deep-sea assemblages.
- Identification of tolerance thresholds for a range of environmental variables (*e.g*., temperature, aragonite saturation), which are fundamental to understanding/predicting climate change impacts; potentially link to research on coral invasion in northwestern Pacific Ocean (*A. japonica*) or vulnerability of *Lophelia pertusa* to ocean acidification in the northeastern Pacific Ocean, and empirical studies of threshold responses. This information could provide insight into vulnerability/resilience of these biogenic habitats. Within the Pacific Ocean, there is North–South gradient in effects of ocean acidification for stony corals, but there is little evidence of this being an issue for soft or black corals. Indeed, little information exists about temperature or other tolerances for soft or black corals. One question might be to undertake an east-west comparison of gradient in carbonate chemistry for stony corals. Tolerances are better known for shallow-water species;
- Development of models of coral and sponge diversity indices (richness, evenness, taxonomic diversity, *etc*.); refer to work by Dr. Charles Veron who is compiling distribution data for corals;
- Linkage of information on genetic structure, connectivity and distributions to improve predictions for species responses to climate change etc. In northeast Pacific Ocean, NOAA's Deep-sea coral Research and Technology Program is analysing genetic samples of *Primnoa pacifica*, while in northwest Pacific Ocean, there is a long-term monitoring program of *A. japonica*;
- Improvement of understanding of the factors that influence recruitment/recovery; fragmentation vs broadcast spawning; what is dispersal potential and suitable conditions for settlement? No signs of recolonization after 15 year closures despite nearby potential source populations. Similarly, no recovery was observed among sponges subjected to trawling in in late 1990s (research by Linc Freese);

- Linkage of research to a shallow coral reef recovery program in south China led by local governments, the program, funded through the State Oceanic Administration (SOA), involves planting/seeding over large areas in southern China;
- Measurement/documentation of coral recruitment rates. Recruitment is episodic and rare. USA has tried to measure recruitment for deepwater corals with settlement plates (Robert Stone, PI), but found no evidence of recruitment. Some data from Japan are available on recruitment of deep-sea precious corals, where recruitment is continuous (Nozomu Iwasaki). Data are available from Japan on coral recruitment on settlement plates dating back to 1970;
- Documentation of coral losses due to eutrophication, damage etc. Develop an understanding of coastal stressors – status/indicator monitoring (*e.g*., water clarity/turbidity);
- Evaluation of the effects of fishing on distribution patterns: What is the influence of the relative amount of effort? Are there thresholds related to disturbance?

Dr. Knudby (Canada) formulated five goals related to development and application of species distribution models:

1. Developing 'basin-wide' (within EEZ is fine) models, and
2. Interpreting their ecological meaningfulness both in terms of predictions and model structure and what it says about species (or order/family/genera) tolerance limits, then
3. For those species/genera we feel we have identified tolerance limits well for, develop some climate projections with a range of assumptions about dispersal, and
4. For those species we have not identified tolerance limits for, suggest data sets that could be accessed or sampling that needs to be done in order to do so.
5. Finally, a test of the use of SDM for definition of biogeographic regions may have potential. The idea would be to use model performance to assess the optimal location of a boundary (*e.g*., along the U.S./ Canada coast, where can we subdivide the coast to achieve optimal model performance on both sides of a boundary?) And does that correspond with expert opinions on biogeographic provinces as well as knowledge of current systems/water masses?

WG 32 members noted that the development of a basin-wide glass sponge model could be novel contribution to the scientific literature.

AGENDA ITEMS 7 AND 8

Review agenda for WG 32 for Day 2 meeting

Dr. Curtis reviewed the agenda with WG 32 members for the next day's meeting before adjourning.

AGENDA ITEMS 9 AND 10

Compilation of data and models of coral and sponge distributions

Dr. Guinotte agreed to coordinate the compilation of deepwater coral record data *i.e*., >50 m depth. Dr. Rooper agreed to take the lead on compiling shallow water coral species <50 m depth. Dr. Knudby will take the lead on compiling data on glass sponges in the North Pacific Ocean. All three will draft templates for data submission/collation and circulate them to members. The data submission template should include absence and presence of data. OBIS contacted the WG 32 Co-Chairs to offer support with development of templates and submission to their online database. They may be potentially linking environmental data to occurrence data. UNEP is also updating its global coldwater database and there is a Millenium Coral Reef Mapping Project being run by the United Nations Environmental Programme World Conservation Monitoring Center (UNEP-WCMC). NOWPAP may be a source of data in the northwest Pacific Ocean. Key questions relate to:

- Which environmental data are available to model future scenarios (*i.e*., responses to climate change)? Minimum and maximum values for environmental variables could be more informative and mean values, especially for shallow-water species. Landsat, MODIS, K490, and other data are available. Obtaining high resolution bathymetry (250 m–1 km) data will be challenging.

- Which coral taxa will be modelled? This will be informed by the availability of data and confidence in taxonomic identification, however, members discussed this question. USA prioritizes reef-forming species, including branching gorgonian corals (Alcyonacea), including *Primnoa pacifica* and *Paragorgia* sp., Isididae, while Canada is developing models for indicators of vulnerable marine ecosystems identified by NPFC and NAFO. The main framework-forming species in the southern portion of the PICES area include *Lophelia pertusa*; *Madrepora oculata*; *Enallopsammia rostrata*. One option identified was to focus first on deep-sea coral and sponge distributions, and then initiate activities on shallow-water species following the PICES-2016 workshop proposed for WG 32.
- How to manage data-sharing agreements? *e.g.*, UNEP may have ownership of data; a Sharepoint site is also used by ICES, *etc*.
- What resolution should the data be in? USA compiles its data to a 5 km grid, while some of Canada's data is on a 1 km grid.
- What spatial scope should be assumed for PICES area? Focus should be northward of 30°N.
    - Does fishing effort influence distribution patterns? There is an effort to compile fishing data led by Dr. Ray Hilborn (USA). Dr. Rooper will follow up on availability of this dataset.
    - How do we standardize species codes (*e.g.*, those used by JAMSTEC, WoRMs OBIS, DFO, *etc*.)? The TCODE Committee may be able to provide guidance on how to address this issue.

Some members suggested that data be submitted to OBIS in Year 3 to give researchers a chance to publish papers related to the data. One potentially fruitful alternative to developing new species distribution models would be to undertake a meta-analysis of existing studies to identify trends common to papers, or differences between western and eastern Pacific ecosystems (or shallow, meso-photic, and deep).

AGENDA ITEM 11
Workshop on biogenic habitat distribution and diversity

WG 32 members developed a proposal to convene a workshop at the 2016 PICES Annual Meeting in San Diego, USA (*WG 32 Endnote 3*). The aims of this workshop are to improve our understanding of factors influencing the distributions of corals and sponges in the North Pacific Ocean, improve habitat models predicting their distribution, and predict how their distributions are likely to shift in response to natural and anthropogenic forcing, including climate change. In preparation for the workshop, members and collaborations will synthesize data, develop models, undertake sensitivity analyses and prepare inputs/outputs for further analysis and interpretation. Sensitivity analyses could examine the effects of model structure/method, data inputs, resolution, taxonomic level, transferability, scalability.

WG 32 members recognized this would require a considerable investment of time and that opportunities to secure funding for research/technical support would help alleviate workloads. Potential sources of funding include NOAA's deep-sea coral program and DFO's International Governance Strategy program.

Members also recognized the potential for participation at the 6th International Symposium on Deep-Sea Corals that will be held in Boston, USA in September 2016.

AGENDA ITEM 12
Biodiversity indicators

Development of biodiversity indicators will follow work on species distribution models. Some discussion points on this topic related to:
- Methodology for collecting data to inform monitoring that is comparable across the North Pacific Ocean;
- Some indicators of threats to biodiversity have been identified (*e.g.*, VME indicator species are indicators themselves).

AGENDA ITEM 13
Associations with fish and invertebrates

There is a need to understand the functional relationship between biogenic habitat that underpins associations with fish/invertebrates (*e.g*., shelter, feeding), but WG 32 members recognized this is difficult to do. Research led by Dr. Rooper and collaborators indicates a higher abundance of rockfish in areas with greater coral density. Members agreed that this term of reference could be addressed through a review of existing literature. This could turn into a primary publication.

Time series data are available for corals and fish in shallow waters within China and may be useful datasets to examine in terms of interactions between fish and corals. Other studies focus on: reproduction of commercial fish, white-streaked grouper (*Epinephelus ongus*), in southern Japan where spawning is associated with branching corals; trends in coral or coral bleaching in relation to grouper dynamics; and interactions between coral reef, groupers, and fishers. In this example, groupers aggregate around coral reefs and provide fishing opportunities, but fishers agree to close areas during the breeding season to ensure sustainability. This is potentially an interesting example to explore in terms of the changes in coral distribution.

AGENDA ITEM 14
Review of proposed WG 32 workshop for PICES-2016

Dr. Curtis reviewed the proposal for 2-day Workshop on "*Distributions of habitat-forming coral and sponge assemblages in the North Pacific Ocean and factors influencing their distributions*" (*WG 32 Endnote 5*) with WG 32 members before adjourning the meeting.

WG 32 Endnote 1

WG 32 participation list*

Members

Kwang-Sik Albert Choi (Korea)
Janelle Curtis (Co-Chair, Canada)
John Guinotte (USA, on behalf of Les Watling)
Masashi Kiyota (Co-Chair, Japan)
Anders Knudby (Canada)
Takeo Kurihara (Japan)
Chris Rooper (USA)
Go Suzuki (Japan)

Observers

Malcolm Clark (New Zealand)
Huang Huo (China)
Oleg Katugin (Russia)
Ian Perry (Canada)
Darlene Smith (Canada)
Thomas Therriault (Science Board Chair)

* Dr. Jianming Chen (China) met independently with WG 32 Co-Chairs in Qingdao, China, on October 18, 2015 to discuss mutual research interests.

WG 32 Endnote 2

WG 32 meeting agenda

Thursday, October 15, 2015; 9:00 – 18:00

1. Welcome, sign-in, and introductions

Meeting objectives:
To review the terms of reference (ToR), exchange information about data availability, and identify opportunities and challenges. WG 32 ToR and members are posted on the WG 32 web page at https://www.pices.int/members/working_groups/wg32.aspx.

2. Terms of Reference

Review the Terms of Reference, and identify key opportunities and challenges. Develop a shared vision on how we carry forward with tasks in eastern, central and western North Pacific Ocean.

3. Review and discussion of coral and sponge distribution modelling in the North Pacific Ocean
    a) Technical issues related to habitat modelling (Kiyota)
    b) Experience with SDM in Atlantic Ocean (Knudby)
    c) Basin wide predictions in Pacific Ocean (Guinotte)

4. Review of available data
    a) Summarize previous studies, ongoing research, and the sources of species and environmental data available in the northeast Pacific Ocean to develop species distribution models for corals and sponges (Canada, USA to prepare short presentations).
    b) Summarize previous studies, ongoing research, and the sources of species and environmental data available in the northwest and central Pacific Ocean to develop species distribution models for corals and sponges (China, Japan, Korea, Russia, USA to prepare short presentations).

5. Identify scientific research questions of mutual interest for PICES WG 32 members

Given discussions of available data, opportunities and challenges, discuss potential research avenues linked to the ToR that could be developed into a PICES Report and primary publication(s) of mutual interest.

6. Linkages with FUTURE (Ian Perry)

Review FUTURE plans and discuss opportunities for WG 32 to link with FUTURE activities.

7. Review Agenda for WG 32 Meeting, Day 2 (October 17, 2015) and other matters

8. Meeting Adjourned; WG 32 Dinner

Saturday, October 17, 2015, 9:00 – 18:00

Meeting objective:

Develop the workplan to achieve the Terms of Reference (ToR) and produce scientific publications of mutual interest. The ToR are posted on the WG 32 web page.

Welcome, sign-in, and introductions (see WG 32 web page for list of WG 32 members)

9. Compilation of data
    a) Develop a plan to compile data on the distribution of corals, sponges, and associated biota, and facilitate their submission to appropriate databases.
    b) Develop a plan to compile data on key variables (temperature, velocity, ocean acidification, slope, aspect) hypothesized to influence coral and sponge distribution and diversity and catalogue sources of multibeam/swathe bathymetry data for distribution modeling.

10. Models of coral and sponge distributions
    a) Develop a plan to review modeling approaches to predict the potential distributions of species and habitat suitability for corals and sponges (*e.g.*, Maxent, Boosted Regression Trees, or high resolution bathymetry-based models).
    b) Develop a plan to identify environmental and ecological predictors of patterns in the distribution and biodiversity of coral, sponge and associated taxa.

11. Workshop on biogenic habitat distribution and diversity

Review the draft proposal to convene a workshop on biogenic habitat distribution and diversity at the 2016 PICES Annual Meeting in San Diego, USA.

12. Biodiversity Indicators

Develop a plan to develop indicators for assessing and monitoring diversity of biogenic habitats.

13. Associations with fish and invertebrates

Develop a plan to study associations between fish and invertebrate species and biogenic habitats

14. Proposed WG 32 workshop at 2016 PICES Annual Meeting
Review WG 32 proposal to convene a session on distribution and biodiversity of biogenic habitat for the 2016 PICES Annual Meeting in San Diego

15. Meeting Adjourned; Evening WG 32 Dinner

WG 32 Endnote 3

Proposal for a 2-day Workshop on
"*Distributions of habitat-forming coral and sponge assemblages in the North Pacific Ocean and factors influencing their distributions*" at PICES-2016

Convenors:
Shallow water corals – Dr. Kwang-Sik Choi (Korea)
Benthic habitat modeling – Dr. Chris Rooper (USA)
Western Pacific Ocean – Dr. Masashi Kiyota (Japan, corresponding convenor)
Eastern Pacific Ocean – Dr. Janelle Curtis (Canada, corresponding convenor)
Deep-sea corals – Dr. Les Watling (USA)

Invited speakers:
Shallow water corals: Dr. Hiroya Yamano (Japan)
Management applications: Dr. Malcolm Clark (NIWA, New Zealand)
Hexactinellida: Dr. Henry Reiswig (Canada)

Changes in the marine environment influence global and regional distribution patterns of marine organisms including corals and sponges in shallow, mesophotic, and deepwater ecosystems. The biogenic habitats formed by these organisms support a broad range of biodiversity, and provide critical habitats for some socio-economically important fishes and invertebrates that attract commercial fishing and other anthropogenic activities. The aim of this workshop is to improve our understanding of factors influencing the distributions of corals and sponges in the North Pacific Ocean, improve habitat models predicting their distribution, and predict how their distributions are likely to shift in response to natural and anthropogenic forcing, including climate change. In preparation for the workshop, WG 32 members and collaborators will compile new data on corals and glass sponges in the North Pacific Ocean as well as existing environmental data to improve model prediction and interpretation based on a multi-model approach. Specifically, deep-sea coral habitat suitability models developed using records from all ocean basins will be improved with the addition of coral location data from the North Pacific Ocean. New habitat suitability models will be developed for deep-sea sponges and multi-model comparisons will be made for both coral and sponge taxa. Workshop participants will be invited to discuss, compare, and evaluate the influence of predictor variable data, and different modelling approaches on results. This process will help identify potential ecological and physiological mechanisms influencing their distributions and provide insight into the potential for changes in their distribution under different climate change scenarios. A novel contribution anticipated from this workshop will be the first habitat predictions for glass sponges (Hexactinellida) at a basin-wide scale in the North Pacific Ocean. Workshop participants will synthesize lessons to be learned from the modelling exercise, future tasks to further improve predictive accuracy, and possible applications for supporting marine spatial planning processes.

Co-sponsoring organization: Marine Conservation Biology Institute; Benthic habitat modeling – Dr. John Guinotte (USA)

Publication: primary paper