Member's report on activities related to ICRI

Reporting period December 2015 – November 2016

1. **Contribution to the ICRI Plan of Action and GM.** *Your responses to the following questions will assist the Secretariat in assessing contributions towards the major themes of the current ICRI Plan of Action (http://www.icriforum.org/icri-secretariat/current) and objectives of the general meeting.*

   a. ***INDCs - Intended Nationally Determined Contributions*** *– Did your national contribution mention 'marine ecosystems or coral reefs'? Would you be interested in joining an Ad Hoc committee to develop guidelines to integrate coral reefs in the INDC?*

With a view to the adoption of a legally binding agreement in Paris in December 2015, the Principality of Monaco wishes to contribute to the joint effort by adopting a target to reduce its emissions by 50% by 2030, compared with the reference year of 1990. However, there is no mention of 'marine ecosystems or coral reefs' in our INDC.

   b. Nature-based Solutions to address Climate Change - *Do you have some example(s) of Nature-based (coral reef and related ecosystems) Solutions to address climate change? If yes, could you please provide use some details?*

On a national level Monaco has not any example to give.

However, the Centre Scientifique de Monaco and the International Atomic Agency will organize in October 2017 the Fourth International Workshop on Bridging the Gap between Ocean Acidification Impacts and Economic Valuation — "From Sciences to Solutions: Ocean Acidification Impacts on Ecosystem Services — Case Studies on Coral Reefs". This Workshop will be devote to explore all forms if adaptation for the future of coral reefs.

Moreover, on the International level, the Ministry of Foreign Affairs and Cooperation of Monaco is supporting, financially, projects related to natural habitat restoration, such as coral reefs, in Small islands developing countries, as a mean to mitigate climate change impact such as sea level rise and land salinization. One of the main supports is given to Secretariat of the Pacific Regional Environment Programme (SPREP) on a programme which has 3 main areas of actions, two of which concern the habitat restoration and species conservation and the Ocean acidification.

   c. *Do you have national measure(s) – existing or in development - to ban the sale and manufacture of cosmetics and personal care products containing plastic microbeads? And plastic bags?*

Since 1 June 2016, the distribution and sale of single-use plastic carrier bags has been banned in the Principality. The aim of this initiative by the Prince's Government, at the instigation of H.S.H. the Sovereign Prince, is to greatly reduce the use of plastics in Monaco.

Along with this ban, and to raise awareness of the issues among the Monegasque community, the Government has introduced an information campaign with the slogan: **"A bag for life".**

This slogan has a two-fold message:

- a reusable bag, which therefore has a longer life;
- a bag made from a natural, biodegradable material.

As a practical way of implementing this initiative, the Government has decided to provide every home in the Principality with a reusable cloth bag, accompanied by an explanatory leaflet. These bags have been distributed by post in September 2016.

This ban is part of a broader approach to promoting responsible trading.
Since 2015, the Department of the Environment has met with more than 200 traders who use plastic bags. The information gathered focused on the type and use of plastic bags, the alternatives envisaged, and, more generally, the management of waste and recycling.

This study showed, in particular, that 95% of Monegasque traders consider that the protection of the environment is a subject of importance to them, or about which they are concerned, and 73% of traders felt that too many plastic bags were distributed.

The aim of this "responsible trading" approach is to encourage eco-friendly practices among traders and consumers in the Principality, targeting the reduction of waste and greenhouse gas emissions.

Now, this support will continue, to prepare for the regulatory deadlines of January 2017 and January 2020.

- On 1 January 2017 there will be a ban on all other single-use bags for wrapping goods at the point of sale (for example the small bags provided for wrapping vegetables in the fresh produce section) that are not compostable and made of at least 30% of biosourced materials. This proportion will increase progressively, reaching 60% in 2025.

- On 1 January 2020, all disposable plastic cutlery will be banned.

The third stage consists in launching the "responsible trading" label, which is being developed in consultation with the traders.

A first draft of this label has been prepared. It aims to implement practical action relating to:

- increased waste sorting;

- reusing wrapping;

- extending the collection of glass bottles in catering establishments and drinks outlets in the Principality with a view to reusing or recycling these bottles.

d. ***Upcoming events -*** *Do you plan to attend:*

- *November 2016 - Marrakech Climate Change Conference / The twenty-second session of the Conference of the Parties (COP 22)* Yes, a delegation of Monaco will be participating.
- *December 4, 2016 to December 17, 2016 - Convention on Biological Diversity COP13* Yes, a delegation of Monaco will be participating
- *June 2017* - Oceans & Seas Global Conference, Fiji Yes, but in New York as it was cancelled in Fidji

2. **Updates on your activities.** The following table is a summary of ICRI's *Framework for Action* (FFA) and its four cornerstones. (The full text of the FFA is available in English,

French, and Spanish at http://icriforum.org/icri-documents/icri-key-documents/continuing-call-action-2013).

Integrated Management	**Objective**	**Manage coral reefs and related ecosystems using an ecosystem approach, recognizing place based activity; connectivity within and among ecological, social, economic, and institutional systems; as well as with attention to scale; resilience of ecological and social systems; and long-term provision of ecosystem services.**
	General Approach	**Integrated management, using a strategic, risk-based, informed approach, provides a framework for effective coral reef and related ecosystem management which supports natural resilience, ecosystem service provision, and enhances the ability to withstand the impacts of climate change and ocean acidification.**
	Desired outcome	**There is a demonstrable reduction in the threats to coral reefs and related ecosystems through management action.**
Capacity Building	**Objective**	**To build capacity in all facets of management of coral reefs and related ecosystems and support dissemination and application of best practices to achieve the widest possible engagement of all stakeholders in planning and management activities.**
	General Approach	**Continued collaboration, partnerships, outreach, information sharing and education to ensure the uptake of best practices and encourage behavioural change. This can only be successful if the diversity of cultures, traditions and governance among nations and regions are taken into account.**
	Desired outcome	**Persons who have influence in the management of coral reef and related ecosystems have the knowledge, tools and capital necessary to apply best practices, adapted to the cultural and socio-economic context.**
Science & Monitoring	**Objective**	**To support research and citizen science approaches to enable countries and communities assess and report on the status of and threats to their coral reefs and related ecosystems in a coordinated, comparable and accessible manner.**
	General Approach	**Research and monitoring programs are essential to ensure that management of coral reefs and related ecosystems is based on best available (scientific) information.**
	Desired outcome	**Knowledge of the status and trends in coral reefs and related ecosystems health is enhanced and used to inform planning and management, improving management outcomes.**
Periodic Assessment (Review)	**Objective**	**To engage in periodic review of the impact and effectiveness of all elements of management to enable evaluation and refinement of management measures in an adaptive framework.**
	General Approach	**Periodic assessments of management effectiveness and evaluation of projects and activities to ensure the efficacy of management tools and systems in tackling the range of pressures affecting coral reefs and related ecosystems and protecting the values associated with them.**
	Desired outcome	**Management processes and activities are regularly reviewed and improved using a structured approach, to enhance their ability to effectively reduce pressures and threats.**

Using the table on the previous page, as well as the detailed descriptors of approaches and strategies available in the full text of the FFA as a reference, please give us an update on an activity/project/program(s) which has been particularly successful in your country/organization during this reporting period.

Project 1

Cornerstone(s) implemented through the project	Check all that apply: ☐ Integrated Management ☐ Capacity Building ☒ Science & Monitoring ☐ Periodic Assessment (Review)
Project Title	Effect of nutrient enrichment on coral physiology
Location	Laboratory experiments
Dates	2015-2016
Main Organizer(s)	Centre Scientifique de Monaco - Department of Marine Biology- Team

	of Coral Ecophysiology/Ecology
Main Stakeholder(s)	Centre Scientifique de Monaco
Description of Project (Please elaborate on how the project implements the FFA cornerstones)	We studied the direct effects of nitrate, ammonium and phosphorus enrichment on the physiology of scleractinian corals. The aims were to assess whether nitrate enrichment is different from the ammonium enrichment and whether the N:P ratio of nutrients in seawater was of a particular importance.
Outcome (Expected outcome)	Better assess the effect of reef eutrophication on the health of corals
Lessons learned	Whereas ammonium enrichment is beneficial to coral health, nitrate enrichment has a negative effect on corals' photosynthesis and calcification. Supplementation of phosphorus and/or supplementation of planktonic food tend to alleviate the negative effects of nitrate. Therefore the N:P ratio of inorganic nutrients in seawater is of a major importance for the health of corals.
Related websites (English preferred)	http://www.centrescientifique.mc/en/BiologieMarine/recherche/ecophysiologie.aspx

Project 2

Cornerstone(s) implemented through the project	Check all that apply: ☐ Integrated Management ☐ Capacity Building ☒ Science & Monitoring ☐ Periodic Assessment (Review)
Project Title	Towards a better understanding of coral calcification and response to ocean acidification
Location	Centre Scientifique de Monaco
Dates	2015-on
Main Organizer(s)	Centre Scientifique de Monaco- Department of Marine Biology- Team of Coral Physiology/Biochemistry
Main Stakeholder(s)	Centre Scientifique de Monaco
Description of Project (Please elaborate on how the project implements the FFA cornerstones)	Corals skeletons are widely used for several purposes ranging from taxonomy, recorders of past-environmental information, bone surgery… Corals build up their skeletons by a biologically controlled process of calcification. As for many other marine calcifiers, corals are threatened by global change including ocean acidification (OA) which impacts the calcification process. Despite a wide literature on the effect of environmental parameters on corals biology, the cellular mechanism of calcification and how and why it is affected by OA is still poorly known. The aim of our group is to dissect the mechanism of calcification in corals from the gene to the organism and to determine the way OA affects this process. We mainly work on a coral species used as a coral model, *Stylophora pistillata*, that we maintain in culture in the laboratory since more than 30 years and for which we have a set of biological, physiological and molecular data. Based on this knowledge, we choose this last year to focus on two aspects: 1) the supply of dissolved inorganic carbon (DIC) for calcification; 2) the impact on OA on several parameters related to calcification, from the molecular to the organism level. **The supply of DIC for calcification**

	The precipitation of calcium carbonate involves calcium and carbonate ions. These ions precipitate at the site of calcification, at the interface between the animal cells and the substrate. We have previously shown that metabolic carbon dioxide (CO_2) produced by calcifying cells is the major source of DIC for calcification. Whereas part of this CO_2 freely diffuses out the cells to the site of calcification, we have shown recently that there is a specific transporter involved in the transcellular transport of bicarbonate. This transporter is specifically localized in the calcifying cells and is only present in calcifying cnidarians (for example it is absent in sea anemones). This active supply of DIC by the cells is responsible for increasing DIC at the site of calcification and thus is a major player of the mechanistics of coral calcification (Zoccola et al. 2015). This work also allowed us to characterize the whole family of bicarbonate transporters in corals by data mining in the genome/transcriptomes. Indeed in collaboration with international colleagues we are working on the genome of *S. pistillata* (article in prep.) and on the genomic and transcriptomic data from twenty coral species (Bhattacharya et al. 2016). **The impact of OA on coral calcification** We have incubated for more than one year *Stylophora pistillata* at low seawater pH (from ambient pH 8.1 to much more acidic seawater pH 7.2) that should favour dissolution of calcium carbonate. However, the corals continued to calcify, albeit at lower rates and maintained their linear extension. Interestingly the coral skeletons that formed at lower pH were significantly more porous and less dense than their counterparts at ambient seawater pH. We showed that pH at the site of calcification was up-regulated compared to pH of seawater and that the explanation underlying why corals skeletons became more porous lay in a biologically-controlled shift in the coral skeleton's architecture, pointing to morphological plasticity (Tambutté et al. 2015, Venn et al. 2015). We have also shown that, under OA, enzymes which play a role in coral calcification, the carbonic anhydrases, show an increase in their activity whereas their expression is decreased and that the effect on enzyme activity can be at least partly counterbalanced by an increase in seawater temperature (Zoccola et al. 2016). Finally we were integrated in a consortium of scientists to exchange ideas on the different levels of calcification studies, from the gene to the ecosystem and to suggest several theoretical tools that may be useful for the study of OA and which take different approaches to understanding complex, multiscale physiological responses of reef calcifiers (Edmunds et al. 2016).
Outcome (Expected outcome)	Both genomic and transcriptomic data will help us identifying new genes that encode proteins potentially involved in the formation of coral skeletons. Combining molecular data with physiological data will be useful to draw models of coral calcification and better understand how OA is affecting the process.
Lessons learned	When studying OA and its effects on coral calcification, transcriptomic data are very useful but must be considered together with physiological data such as enzyme activity. The effect of multi-stressors parameters must be considered when interpreting data from single parameter experiments as one parameter can counterbalance the effect of the other.

	Even if "coral tolerant species to OA" maintain their linear extension rate under OA, their calcification rate decreases and their overall skeleton architecture is affected with more porous phenotypes making corals more vulnerable to damage and bioerosion.
Related websites (English preferred)	http://www.centrescientifique.mc/en/BiologieMarine/recherche/Physiologie.aspx

Project 3

Cornerstone(s) implemented through the project	Check all that apply: ☒ Integrated Management ☐ Capacity Building ☐ Science & Monitoring ☐ Periodic Assessment (Review)
Project Title	Coral Reefs Management and Decision Making Tools
Location	Centre Scientifique de Monaco
Dates	2015 - on
Main Organizer(s)	Centre Scientifique de Monaco- Department of Marine Biology- Team of Environmental Economy
Main Stakeholder(s)	Centre Scientifique de Monaco
Description of Project (Please elaborate on how the project implements the FFA cornerstones)	In this study, we examine the problem of coral reef destruction and discuss various stakeholders who suffer losses from the destruction. We then postulate a stakeholder versus threats matrix and outline an algorithm where public authorities can streamline policy based on expected losses. We also formulate, using local data, divergence between the public good and individual benefits and examine the agent behaviour under monitoring.
Outcome (Expected outcome)	This research is important to decision makers in the areas of fragile coral reef environments to strategize priorities, given limited budget constraints. The readership of Ocean and Coastal Management may be able to, using data collected for their region, duplicate the strategy and apply the most efficient solution to protect the coral reefs in their region.
Lessons learned	Methodology: - Profit-loss matrices assess damages under uncertainty per stakeholder or per threat source, - Payoff matrices in Indonesia and Philippines and Nash equilibrium strategy in game theoretical model give indications to policy-makers, - Natural resource management concerns both people and natural resources, - As coral reefs are considered as a common property, we apply a community-based natural resource management.
Related websites (English preferred)	http://www.centrescientifique.mc/fr/CurriculumVitae/Hilmi-Nathalie-22.html

3. **Publications.** Please list relevant publications/reports you have released during this reporting period.

Title (incl. author and date)	Website URL if available	Type of publication (Paper, report, etc.)
ECOPHYSIOLOGIE		
Levy, O., Karako-Lampert, S., Waldman Ben-Asher, H., Zoccola, D., Pagés, G. and Ferrier-Pagès, C. (2016) Molecular assessment of the effect of light and heterotrophy in the scleractinian coral *Stylophora pistillata*. Proc Biol Sci 283(1829).	http://rspb.royalsocietypublishing.org/content/283/1829/20153025	Proc Biol Sci
Leal, M.C. and Ferrier-Pagès, C. (2016) Molecular trophic markers in marine food webs and their potential use for coral ecology. Mar Genomics.	http://www.ncbi.nlm.nih.gov/pubmed/26896098	Mar Genomics
Gori, A., Ferrier-Pagès, C., Hennige, S.J., Murray, F., Rottier, C., Wicks, L.C. and Roberts, J.M. (2016) Physiological response of the cold-water coral *Desmophyllum dianthus* to thermal stress and ocean acidification. PeerJ 4, e1606.	http://www.ncbi.nlm.nih.gov/pubmed/26855864	PeerJ
Godinot, C., Gaysinski, M., Thomas, O.P., Ferrier-Pagès, C. and Grover, R. (2016) On the use of 31P NMR for the quantification of hydrosoluble phosphorus-containing compounds in coral host tissues and cultured zooxanthellae. Sci Rep 6, 21760.	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4763230/	Scientific Reports
Ezzat, L., Towle, E.K., Irisson, J.O., Langdon, C. and Ferrier-Pagès, C. (2016) The relationship between heterotrophic feeding and inorganic nutrient availability in the scleractinian coral *T. reniformis* under a short-term temperature increase. Limnol Oceanogr 61(1), 89-102.	http://onlinelibrary.wiley.com/doi/10.1002/lno.10200/abstract	Limnol Oceanogr
Ezzat, L., Maguer, J.F., Grover, R. and Ferrier-Pagès, C. (2016) Limited phosphorus availability is the Achilles heel of tropical reef corals in a warming ocean. Sci Rep 17(6), 31768.	http://www.nature.com/articles/srep31768	Scientific Reports
Ezzat, L., Maguer, J.-F., Grover, R. and Ferrier-Pagès, C. (2015) New insights into carbon acquisition and exchanges within the coral–dinoflagellate symbiosis under NH_4^+ and NO_3^- supply. Proc R Soc B 282(1812), 20150610.	http://rspb.royalsocietypublishing.org/content/282/1812/20150610	Proc R Soc B
PHYSIOLOGIE		
Zoccola D, Ganot P, Bertucci A, Caminiti-Segonds N, Techer N, Voolstra CR, Aranda, M., Tambutté, E., Allemand, D., Casey, J. R., Tambutté, S. (2015) Bicarbonate transporters in corals point towards a key step in the evolution of cnidarian calcification. Scientific reports. 5:9983.	https://pdfs.semanticscholar.org/74e3/08935bc74e2f26e23d6045f68f1525de3e87.pdf	Scientific reports
Venn, A.A., Tambutte, E. and Tambutte, S. (2015) Plasticity of coral physiology under ocean acidification. Oncotarget 6(21), 18248-18249.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4621887/	Oncotarget
Tambutte, E., Venn, A.A., Holcomb, M., Segonds, N., Techer, N., Zoccola, D., Allemand, D. and Tambutte, S. (2015) Morphological plasticity of the coral skeleton under CO2-driven seawater acidification. Nat Commun 6, 7368.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4490415/	Nat Comm
Zoccola, D., Innocenti, A., Bertucci, A., Tambutté, E., Supuran, T.C. and Tambutté, S. (2016) Coral Carbonic Anhydrases: Regulation by Ocean Acidification. Marine Drugs 14(6).	http://www.mdpi.com/1660-3397/14/6/109	Marine Drugs
Edmunds, P.J., Comeau, S., Lantz, C., Andersson, A., Briggs, C.,	http://bioscience.oxfor	BioScience

Cohen, A., Gattuso, J.-P., Grady, J.M., Gross, K., Johnson, M., Muller, E.B., Ries, J.B., Tambutté, S., Tambutté, E., Venn, A. and Carpenter, R.C. (2016) Integrating the Effects of Ocean Acidification across Functional Scales on Tropical Coral Reefs. BioScience.	djournals.org/content/early/2016/03/29/biosci.biw023	
Bhattacharya, D., Agrawal, S., Aranda, M., Baumgarten, S., Belcaid, M., Drake, J.L., Erwin, D., Foret, S., Gates, R.D., Gruber, D.F., Kamel, B., Lesser, M.P., Levy, O., Liew, Y.J., Macmanes, M.D., Mass, T., Medina, M., Mehr, S., Meyer, E., Price, D.C., Putnam, H.M., Qiu, H., Shinzato, C., Shoguchi, E., Stokes, A.J., Tambutté, S., Tchernov, D., Voolstra, C.R., Wagner, N., Walker, C.W., Weber, A.P.M., Weis, V., Zelzion, E., Zoccola, D. and Falkowski, P.G. (2016) Comparative genomics explains the evolutionary success of reef-forming corals. Elife (Cambridge) 5, e13288.	https://elifesciences.org/content/5/e13288	eLife
ECONOMIE ENVIRONNEMENTALE		
Lacoue-Labarthe, T., Nunes, P.A.L.D., Ziveri, P., Cinar, M., Gazeau, F., Hall-Spencer, J.M., Hilmi, N., Moschella, P., Safa, A., Sauzade, D. and Turley, C. (2016) Impacts of ocean acidification in a warming Mediterranean Sea: An overview. Regional Studies in Marine Science 5, 1-11.	https://hal.archives-ouvertes.fr/hal-01253944	Regional Studies in Marine Science
Hilmi, N., Bambridge, T., Safa, A., Quinquis, B. and D'Arcy, P. (2016) Socioeconomic significance of fisheries in the Small Island Developing States: natural heritage or commodity? Pacific-Credo publications.	https://hal.archives-ouvertes.fr/hal-01357658	Pacific-credo publications

4. **General Information.** (Note that this information will be posted on the ICRI website on your member page: http://www.icriforum.org/about-icri/members-networks.)

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