Template for Annual SCOR Working Group Reports to SCOR

1. Name of group

Floating Litter and its Oceanic TranSport Analysis and Modelling (FLOTSAM)

2. Activities since previous report to SCOR (e.g., virtual or in-person meetings, email discussions, special sessions). Limit 1000 words

WG153 has been approved after the 2017 Annual Meeting in September in Cape Town, South Africa, and this is the first annual report.
A lot of the 9 months' initial activity has been concerned with the logistics of organization and communication, with large exchange of emails and Skype meetings. However, significant scientific progress has also been achieved through web conference discussions, scientific meetings and the first kickoff workshop. For example, well in advance to the workshop, a list of key questions has been shared among partners using Google Drive and they were a common starting point to stimulate and to target face-to-face discussion. The WG has also been communicated to the scientific community and to media, as National Geographic, national newspapers and televisions (RAI and Sky).

3. Documents published since previous report to SCOR (e.g., peer-reviewed journal articles, reports, Web pages) and should be limited to publications that resulted directly from WG activities and which acknowledge SCOR support

A website has been created at http://scor-flotsam.it and regularly updated. It is hosted on GitHub and CNR servers and administrated by E. Van Sebille. WG 153 is also hosted in SCOR website (http://www.scor-int.org/SCOR_WGs_WG153.htm).

A session was convened by all SCOR WG 153 PIs (*Law, van Sebille, Maximenko, Aliani*) and partner (*Won Joon Shim*) at the 2018 Ocean Sciences meeting in Portland, OR, USA inviting presentations on the focus of the working group: Detection, Analysis and Modeling of the Distribution and Transport of Oceanic Debris.
FLOTSAM participants presented the outcome of the fist WG153 workshop at the 6th International Marine Debris Conference in San Diego, CA, USA. (http://internationalmarinedebrisconference.org/).

Four relevant sessions and one plenary were convened by participants of WG 153. Reports were delivered to NOOA and available soon in 6IMDC Session Summaries of Conference Proceedings:

- PLENARY SESSION of Wednesday, March 14, 8:30 - 10:00 AM *Kara Lavender Law*, Sea Education Association.
- Session Chairs: *Erik van Sebille*, Utrecht University; *Kara Lavender Law*, Sea Education Association TRANSPORT AND FATE OF MARINE DEBRIS IN THE OCEAN AND SHELF-SEAS: THEORY, MODELING AND OBSERVATIONS (double session)
- Session Chairs: *Nikolai Maximenko*, University of Hawaii; Delwyn Moller, Remote Sensing Solutions; *Bertrand Chapron*, IFREMER; *Paolo Corradi*, ESTEC; *Victor Martinez Vicente*, Plymouth Marine Laboratory REMOTE SENSING OF MARINE DEBRIS IN THE OPEN OCEAN

- Session Chairs: Georg Hanke, European Commission Joint Research Centre Directorate D Sustainable Resources; *Stefano Aliani*, CNR-ISMAR QUANTIFICATION OF FLOATING MARINE MACRO LITTER
- Session Chairs: Chelsea Rochman, University of Toronto; Sang Hee Hong, Korea Institute of Ocean Science and Technology; *Won Joon Shim*, Korea Institute of Ocean Science and Technology; Jennifer Lynch, National Oceanic and Atmospheric Administration; Hideshige Takada, Tokyo University of Agriculture and Technology; Hrissi Karapanagioti, University of Patras THE CHEMISTRY OF PLASTIC MARINE DEBRIS (double session)

Abstract have been accepted for special sessions on WG153 topics at IAPSO/IUGG Assembly in Montreal, 10-17 July 2019. Leading author was *Erik van Sebille*. http://iapso.iugg.org/

Abstract for a community white paper have been accepted at OceanObs'19 in Honolulu 16-20 September 2019 Leading author was *Nikolai Maximenko*. http://www.oceanobs19.net/

4. Progress toward achieving group's terms of reference. List each term of reference separately and describe progress on each one. Limit 1000 words

The WG made relevant progresses toward objective through a kickoff meeting, sessions at scientific congresses, email exchanges and Skype calls.

TOR1 - Identify gaps in our knowledge of the near-surface ocean dynamics that may affect litter distribution and transport

During the workshop participants discussed and agreed on a list of relevant oceanographic processes affecting marine litter distribution and transport. Coastal processes and open ocean processes were considered separately, giving priorities to coastal and open ocean according to scientific relevance and current level of knowledge. It was noted that the observations required for basic research are often different from those collected for monitoring/management purposes.

Processes that at the present state of knowledge are relevant have been listed and WG discussed what we know about these, how important they may be for marine debris studies, how easily the process can be measured. They have been separated in different categories: transport processes that accumulate vs. disperse (redistribution at the surface); processes that flux material to/from the surface, including sources and sinks; Processes that change the particle properties.

Observations required to understand the relevant processes have been discussed. Existing observations are based upon sampling surface ocean trawling nets (different mesh sizes may be source of critical heterogeneity), bulk water sampling, visual surveys, ingestion of plastic by birds (and other organisms), separation of samples by filtration (again mesh size may be relevant). Polymers chemical characterization is a must to separate plastic from natural debris, especially at sizes smaller than ~300 um. All participants agreed that data sets must be comparable, which involves harmonization of methods, and data quality must include some basic information for example particle characterization (size, polymer type- smaller sizes) in order to achieve a plastic taxonomy. Litterbase data facility has been introduced (http://litterbase.awi.de/) and other databases have been cited. The problem of QC/QA has been discussed, which is a necessary step toward the creation of time series, I.e. repeated transects over time. The role of citizen science as a source of global data was discussed too.

TOR 2 - Improve future marine litter modelling capabilities

The current state of modelling of marine debris has been discussed during the kick-off workshop and during internal Skype meetings. There was a general agreement that many papers published in recent years were based upon transport models commonly used to describe other types of objects (oil or larvae) and no model is fully dedicated to marine debris. There is an ecosystem of possible models suitable for marine debris studies but at present they are without a proper parametrisation of key processes affecting debris. For example, the role of Stokes drift has been considered in recent papers but more work is needed to achieve a full comprehension of its effect on marine debris and properly include in model parametrisations and set ups. Other relevant processes should be included in model parametrisation and to disentangle coastal processes (with their short timescales) from the open ocean low-frequency processes, effort is also required in nesting large scale and high-resolution models. Participants to modelling subgroup scheduled regular web conferences.

TOR3 - Evaluate existing and emerging remote sensing technologies that can be applied to marine litter in the open ocean

Aspects related to remote and in situ observations have been discussed at the kick-off meeting and a plan for next year activities has been agreed, including the community white paper to be submitted in 2018. Some points have been highlighted to focus on for the next decade of science. Outcomes of the meeting highlighted that remote sensing provides the bigger picture and that, very often, it's difficult to draw line between remote sensing and observations. New technologies are required for future remote observations, including new sensors, e.g. optical (visible spectrum) and IR. The IR range is very promising, as seawater is almost black, so even small particles of plastic would be very bright, but if surface of the plastics is wet it may block the signal. However, good possibility may come from spotting shorelines and possibly large objects sticking out of the water. Hand held drones may be useful in accumulation hot spots to overcome the low resolution of satellites. Active Raman sensors require a powerful source of energy, which is good in the lab, but may not be good for the field and satellites. The SAR active sensor can get a height profile of large floating objects, get information about surface currents, waves and the speed of objects (windage), therefore although it cannot characterize small sized objects, it may collect information about variables relevant to explain ocean processes. Plastics and biological material respond the same way to fluorosensors, making separation very difficult, but these sensors offer opportunities to address the interaction with marine life. LIDAR penetrates the ocean surface and the reflected signal could potentially give vertical distribution, but the signal also reflects off air bubbles, which are used to study vertical mixing. SST and ocean color can track small features in time and identify sharp fronts, but requires proper validation and ground truthing. Direct measurements of drifting objects are important (which use satellite systems for position tracking) as well as of the surface ocean current. Although these measurements won't estimate plastic directly, they are important variables to improve models.

ESA funded 2 projects related to remote sensing of marine debris on the shoreline and in the open ocean. The OPTIMALI project contacted FLOTSAM partners to share a questionnaire about remote sensing to organize an ESA workshop in Noordwijk on 30 November 2017. WG153 was represented by *Erik Van Sebille* and *Stefano Aliani*. *Victor Martinez-Vicente*, OTIMALI coordinator and member of FLOTSAM, got 50% replies to his questionnaire and is drafting a ms to be submitted for publication.

TOR4 - Improve awareness of the scientific understanding of marine debris, based on better observations and modelling results.

FLOTSAM website has been published and updated.

Participants of WG153 chaired sessions at Ocean Science Meeting 2018 in Portland, OR (USA), and 6IMDC in San Diego, CA (USA).
Presentation of WG153 were delivered in many institutions; among them at ESA in Rome and broadcasted to all interested ESA facilities in EU, School of Scientific Journalism at University of Milan, East China Normal University (Shanghai).
Communication with media at RAI Italian TV, BBC... and some interviews with newspapers.
Contacts have been taken, or are going to be taken soon, to collaborate with GESAMP, UNEP and IUGG/IAPSO.

5. WG activities planned for the coming year. Limit 500 words

Next FLOTSAM annual workshop is planned in Utrecht (NL) spring 2019. The topics and the agenda of this workshop will be drafted after web discussion using web conference systems and Slack web services. Webinar discussions may be plenary with all interested partners involved and with focused subgroups.

WG153 will be also present at:
PAME - June 2018, Iceland
IASC - June 2018, Davos
MICRO – Nov 2018, Lanzarote
EGU – April 2019, Vienna
IUGG – July 2019, Montreal
OceanObs – Sep. 2019, Honolulu

Publications in preparation are:

- OceanObs19. Our abstract has been selected for a white paper on floating marine debris observations. Obs19 organizers identified four other abstracts potentially complementing ours and recommended combining efforts into a white paper on Marine Litter. *Nikolai Maximenko*, who is leading all abstracts, is contacting the teams and, once all agree, will start preparing the structure and assignments of sections of the full-size paper to be submitted to *Frontiers in Marine Science* by September 30, 2018.
- Presentation of WG at Oceanography/EOS. A presentation of the WG and some results of kickoff meeting will be advertised on EOS or Oceanography journal. Manuscript is under preparation.
- WG participant will lead a session at IUGG/IAPSO meeting in Montreal next year, focussing on the Role of ocean processes in the transport and fate of floating plastic litter in the ocean and shelf-seas: theory, modelling and observations.
- A number of papers about outcomes of WG153 workshop are expected to be submitted to A Virtual Special Issue in Marine Pollution Bulletin, dedicated to 6IMDC. Special Issue content will be published in regular issues of Marine Pollution Bulletin as they are accepted. Accepted submissions will also be compiled in a Virtual Special Issue, easily accessible and navigable on ScienceDirect.
- A multi authored paper lead by *Victor Martinez Vicente* is going to be submitted to *Frontiers Marine Science* as a Perspective Paper. Provisional title is: Towards global remote sensing of marine debris: scientific questions, current capabilities and research needs.

6. Is the group having difficulties expected in achieving terms of reference or meeting original time schedule? If so, why, and what is being done to address the difficulties Limit 200 words

No difficulties encountered or foreseen to achieve TORs as scheduled.

7. Any special comments or requests to SCOR. Limit 100 words.

Additional information can be submitted and will be included in the background book for the SCOR meeting at the discretion of the SCOR Executive Committee Reporter for the WG and the SCOR Secretariat.