Algae form the base of the marine food web, but harmful algal blooms can wreak damage across large areas, including large-scale marine mortality events, and are associated with various types of shellfish poisonings. Henrik Enevoldsen, Head of the IOC’s Science and Communication Centre on Harmful Algae outlines important work it is conducting in this research area.

Can you begin by explaining the process by which algal blooms adversely affect the health of oceanic waters and even humans? What makes them harmful?

Algae can become harmful via two primary routes. The first is through the production of a variety of toxins that accumulate in the algal cells or are released into the surrounding water. These toxins can harm aquatic life directly by entering the food web where they reach high concentrations in organisms such as shellfish or fish. In turn, predators that feed on these organisms – such as marine mammals and humans – can be poisoned or killed. Toxins can also be inhaled when they are aerosolised by wave action. This often happens on beaches and can cause respiratory problems.
The proliferation of Harmful Algal Blooms (HAB) is an emerging trend. As Technical Secretary of IPHAB, what are your main responsibilities? How does the IPHAB contribute to the structural organisation of the IOC and the wider responsibilities of UNESCO?

As Technical Secretary of IPHAB my primary responsibility is to jointly lead the IOC’s Harmful Algal Bloom (HAB) Programme with the Chair of the Panel, including setting priorities and ensuring relevance to Member States. One of the ways in which we can ensure that the Programme addresses Member States’ priorities is to strengthen regional HAB organisations that coordinate and raise issues of regional concern. Communicating these priorities to IPHAB can help to mobilise the scientific assistance to manage these regional HAB problems. This scientific assistance can be provided by international bodies such as the international research programme Global Ecology and Oceanography of Harmful algal Blooms (GEOHAB) which IPHAB has established jointly with the Scientific Committee on Oceanic Research (SCOR). IPHAB can then use Member State priorities to drive science programmes at the global, regional and national levels. When IPHAB meets every two years, these priorities are captured in resolutions, recommendations and a workplan that are brought to the IOC Assembly for endorsement.

IPHAB is an example of a specialised yet typical activity of UNESCO, providing an interactive link between science and governments, science and application, and creating the global and regional platforms and structure for concrete action such as capacity development, knowledge sharing and, in general, the sustainable use of natural resources. Finally, IPHAB provides links between UN agencies and other organisations that have mandate to address various aspects of this highly multidisciplinary field (food, health, shipping etc.). If we do our job effectively, this should imply that Member States gain a more coherent assistance and tools to address the HAB issue integrated in larger societal themes at the national level.

The proliferation of Harmful Algal Blooms (HAB) is an emerging trend. Can climate change alone be the causal factor? What else may be contributing?

The term HAB is a societal one, not scientific. Harmful algae are in fact a diverse group of unrelated organisms causing a long array of very different effects depending on occurrence, timing and what human activity it coincides with. As such, there are as many causal factors as there are types of harmful algal events. However, there are common features driving common events of common species in comparable systems, eg. typical factors that control blooms in upwelling systems, events in nutrient rich systems etc.

To a large degree we are conducting research in basic phytoplankton ecology to understand the factors controlling the occurrence of harmful algal events. Often, several factors will be working together to provide the conditions for proliferation of a given harmful plankton species, including temperature, nutrient loading, weather events, grazing pressure changes in the ecosystem at higher or lower trophic levels etc. Therefore, the most successful models to forecast HAB events are system specific, modelling a specific ecosystem.

Understanding if climate change has or potentially will impact HAB occurrences is extremely complex as a changing climate will alter many of the parameters that govern phytoplankton population dynamics. Furthermore, we rarely have sufficiently long time series of data to know if the changes we observe are unusual or cyclic, but it is an issue the scientific community struggle with and which we will focus on in the coming years to ensure that any hypothesising on the impact of climate change on HAB occurrences is based on solid science.

Eutrophication is becoming an ever-increasing problem for water courses. Could agricultural runoff and industrial processes be a concern to coastal regions also?

Degradation of water quality and nutrient input in coastal systems are expected to increase in many world regions in the future unless corrective actions are taken. It is well-established that eutrophication is a major environmental problem in many coastal ecosystems around the world.

Nutrient sources driving coastal eutrophication are primarily associated with increasing human population, food and energy production in watersheds and, in some cases, coastal aquaculture. The effects of eutrophication are various and may include increased algal biomass, high-biomass HABs, hypoxia/anoxia, seagrass decline, increased water turbidity, and change in fisheries yields. One of the aspects we focus on in our work is if we can predict how natural and anthropogenic factors interact to modulate coastal zone ecosystems and stresses on organisms from phytoplankton to fish.

The relationships between nutrient loading and ecosystem effects are complex and variable and depend on the specific nutrient sources and the physical dynamics of the receiving waters, among many other factors! We work closely with UNEP on this issue and with the Global Partnership for Nutrient Management.

Is the IOC working to identify the pollution pathways and source of these algae blooms?

Such questions are in the first instance research questions. To address them, the IPHAB has, as mentioned above, jointly with SCOR, established GEOHAB. This fosters international cooperative research on HABs in ecosystem types sharing common features, comparing the key species involved and the oceanographic processes that influence their population dynamics.

GEOHAB is an international programme that coordinates and builds on related national, regional and international efforts in HAB research within an ecological and oceanographic context. GEOHAB will encourage combined experimental, observational and modelling approaches, using current and innovative technologies in a multidisciplinary approach that is consistent with the multiple scales and oceanographic complexity of HAB phenomena. Through such efforts, the emergence of a truly global synthesis of scientific results should be attained.

The scientific results emerging from initiatives like GEOHAB can and are being used by MS to develop or optimise monitoring and management of harmful algal events as well as of the conditions leading to HAB events in the cases where these are linked to human activity of the way marine resources are being exploited.

Conservation bodies and marine scientists felt disheartened as a result of Rio+20. Would IPHAB agree with this sentiment?

IPHAB has not taken any position on the result of Rio+20, but the outcome document of the United Nations Conference on Sustainable Development,
Rio+20, entitled ‘The Future We Want’ includes specific follow-up by DOALOS, UNEP, and IOC/UNESCO, namely to complete the first global integrated assessment of the state of the marine environment by 2014. With this UN World Ocean Assessment we will better understand the status, trends and interrelations in the marine ecosystem, and gain a better understanding of how human activities put pressure on and impact marine ecosystems.

Furthermore, there is the World Bank-led Global Partnership for Oceans which is a growing alliance of over 100 governments, international organisations, civil society groups and private sector interests that will mobilise knowledge and financial resources to address threats to ocean health, resilience and productivity. Their objectives by 2022 are to have sustainable seafood and livelihoods from capture fisheries and aquaculture, halve the current rate of natural habitat loss, and reduce pollution of the marine environment. This may become a very strong and important framework for implementing IPHAB activities on HAB management in relation to fisheries and aquaculture, develop capacity and manage better relations between nutrient enrichments and HAB events.

**To what extent is GEOHAB multidisciplinary? How does it benefit the wider scientific community in developing a greater understanding of the marine environment?**

The multidisciplinary aspect of HAB research is unavoidable. Today ecosystem research spans from molecular techniques in the laboratory to large-scale ocean measurements to ecophysiological studies. Moreover, the development of new HAB or HAB species, or toxin observation and toxicity testing technologies, draw on many disciplines and research communities. As HABs are defined by their impact on human activity, their study requires disciplines including epidemiology, mitigation techniques, fish behaviour and even sociological and cultural patterns.

As HAB-causing species are scientifically a part of the pelagic ecosystem, the focused research effort on HABs contributes directly to our general knowledge and understanding of the marine ecosystem. The establishment of GEOHAB has allowed fundamental questions in plankton ecology to be systematically addressed and this is much needed in a time where society expects fast, applicable results from science. With GEOHAB we endeavour to both deliver new and synthesised knowledge that is applicable and address the deeper complex and longstanding big questions.

**IPHAB’s Medium Term Strategy currently focuses on capacity building, cooperative research and an authoritative integrated information system of HABs. What have been the major successes for this term? How will this guide future priorities?**

The main successes are:

- A unique global platform for training in skills needed to monitor and manage HAB events
- The only shared and free access compilation of data on HAB events
- The GEOHAB research initiative, which has significantly influenced the research agenda

We will continue to listen carefully to the needs of Member States and their agencies; this is what guides us. As the HAB issue is not going away we expect the needs for internationally coordinated action to remain but of course to adjust its focus as societal needs change and as science delivers management and mitigation solutions.

**In your opinion, what is the greatest challenge currently facing IPHAB? How do you hope to overcome this?**

As for all of the UN agencies, the major challenge is the dwindling financial contributions for our work. The countries that have traditionally been the most generous contributors to fund international collaboration have budget problems or have changed policy. This requires us to refocus many activities and in many cases do what is possible instead of what is most needed. However, we are witnessing new Member States stepping in and taking responsibility and this is very encouraging too. Fortunately, part of the work we do only requires limited resources – mostly human resources – to facilitate processes, establish platforms for dialogue and transmission of science to the governments, policy makers and other stakeholders.

The IOC recently celebrated its 50th birthday. What are your hopes for the next 10 years?

I hope most of all that the introduction of the oceans and the marine environment into a high level international agenda – as we saw at Rio+20 – will continue. With the ‘The Future We Want’ and new ocean orientated initiatives such as Ocean Compact, I hope the UN system will be able to strengthen and condense its work on the oceans and the marine environment. Today, this work is scattered across many different agencies which means it is a challenge to coordinate and hard for Member States to build effective foundations within their national administrations. At the level of IPHAB and harmful algal events, I strongly hope it will continue to deliver initiatives and products which facilitate generation of new knowledge, sharing of this knowledge and its application for the benefit of us all: this is why the IOC of UNESCO and governing bodies like IPHAB exist.