4. APPROACH TO DESCRIBING TROPHIC SYSTEMS

The project methods for describing the trophic systems are outlined as a series of steps below:

4.1 Development of generic conceptual trophic system model

We reviewed the quantitative EcoPath/EcoSim trophic model developed by Bulman (2006) in the NWMR as part of the North West Shelf Joint Environmental Management Study project. Following on from this review, and in discussions with the author Dr Cathy Bulman, other CSIRO staff and DEW, a modified approach was developed that took into consideration the fact that EcoPath/EcoSim models are time consuming and focussed on fisheries applications; resource for the current project were very tight, and that our research focus was much broader. The key aspects of this new approach were the aggregation of biological trophic information to the functional group level, explicit incorporation of habitat information and key drivers, and identifying services provided by, or linkage interactions between, systems. This step involved identifying regional drivers, and using any existing quantitative models, data, publications and expert opinion to develop trophic models that were broadly representative of those in the NWMR. DEW assisted in this task by providing relevant references and expert compilations on the following components: invertebrates, large pelagics, cephalopods, whales, seasnakes, turtles, seabirds, commercial fisheries, geomorphology and oceanographic drivers.

4.2 SYSTEMS OF THE NWMR

The generic model developed above was implemented in the NWMR by identifying the broad regional differences in oceanographic forcing that would affect the trophic systems. Key considerations we took into account included:

- A review and qualitative assessment of drivers of the trophic systems in the NWMR (e.g. oceanography, sediments, geomorphology, productivity/nutrients, climate, habitats, species composition, terrestrial inputs) and how these might result in differences in broad trophic systems across the region;
- A description of how the trophic systems of the NWMR may differ from other marine regions around Australia because of their component species groups and/or habitats;
- Identification of important habitats and species in the NWMR based on their role in trophic systems;
- Information provided by DEW from their literature reviews and through their separate consultations with key experts.

Following on from this approach, we developed a generic conceptual representation of how the region, the sub-regions their trophic systems and important features, all relate to each other. A model of this concept is illustrated in Figure 4-1.

At the broadest level, the NWMR is defined by regional oceanographic, climatic, geophysical and biological drivers that are quite different to its neighbouring regions (identified in Figure 4-1 by the box on the right) such as the South West and Northern Marine Regions. The NWMR may provide services to the community, conservation, various industries and other uses, including services to neighbouring systems. It may also use services from neighbouring systems in the form of species, genes, population, nutrients and other water properties that are important to the trophic systems of the NWMR.

A sub-region contains a unique set of drivers that control its environment and variation at the larger timescales: for example, tidal, seasons, interannual and climatic. Drivers may provide, and alter, the input of biotic and abiotic elements that affect the productivity of the system and the services it provides. Drivers may also disturb and redistribute elements of the system.

Sub-regions may be responsible for elements of services provided by the regional system and they may also preferentially, or otherwise, use the services provided by neighbouring sub-regions. Thus each sub-region has a local set of drivers and services including exchanges with neighbouring sub-regions (Figure 4-1 and Figure 4-2). Within each sub-region there is a collection of trophic elements (denoted by “T” in Figure 4-1) which may comprise functional groups or biota that are of importance to the functioning of the sub-region and/or to the services it provides. The trophic elements are associated with a set of habitats (denoted by “H” in Figure 4-1).

Part of the exchange, or linkage, between sub-regions may be from a dependence of a set of trophic elements on habitats in more than one sub-region (denoted for example by the red dashed line in Figure 4-1 that crosses sub-regions 1 and 2). Features within sub-regions may comprise important trophic elements (denoted by “t” within the larger “T” trophic groups in Figure 4-1), which in turn are associated with one or more important sub-habitats (denoted by “s” within “H”) that are part of the sub-region suite of habitats.

The issue of linkage between habitats and trophic elements is highlighted in Figure 4-1 as dashed lines which show the types of interactions that are possible. An important aim of the sub-region descriptions is to identify and characterise these linkages.

4.3 APPROACH, JUSTIFICATION AND CONTEXT

In characterising the trophic systems in the NWMR we used a combination of known scientific information and expert opinion. In particular, the compartmentalisation process used a hierarchical process beginning with the major physical drivers that form the foundations of habitats and determine the biogeochemical characteristics of the region. At the top level, we used the pelagic regionalisation by Lyne and Hayes (2005) (see Figure 5-9) as the primary basis for defining the systems of the NWMR. The Lyne and Hayes, (2005) classification used offshore information on water masses and was less accurate on the shelf. Therefore on the shelf and slope, the regionalisation based on fish by Last *et al* (2003) and the IMCRA demersal shelf regionalisation by Lyne and Last (1996) were used to assist the definition of the sub-regions.

The trophic systems, or sub-regions were described using maps, conceptual models, diagrams and a concise written narrative. The narratives have focussed on the species and species groups (e.g. trophic functional groups) that we believe might play significant ecological roles in the sub-regions being described. More comprehensive species lists may be available for some sub-regions and can be obtained by way of the literature cited in the document.

Much of the scientific information exists in either scientific papers or reports, although some of the information was summarised from existing data held by CSIRO and AIMS. The expert opinion was gathered during workshops held with scientists from CSIRO (Hobart – 28th-29th March), AIMS (22nd-23rd May, 1st-2nd August); and through emails and phone calls to individual experts (e.g. sea turtles – Colin Limpus, Qld NPWS).

Describing trophic systems of the scale of the NWMR is potentially a very large and difficult task. Defining the boundaries of individual sub-regions is complex. However, to provide an adequate, but useful level of information for the purpose of the Bioregional Profile we restricted the description to a relatively small number (eleven) of trophic systems. These were created and agreed upon through workshops and discussions using the conceptual approach described previously in conjunction with information on the main physical drivers and known ecological community boundaries (see Sections 4.3 and 5, below).

Please note: In instances where a comment is not referenced the authors have drawn conclusions about the trophic system based upon broad scientific theory and/or what can be inferred from other marine environments. The need for further research in these instances is often noted in the ‘data gaps’ sections.

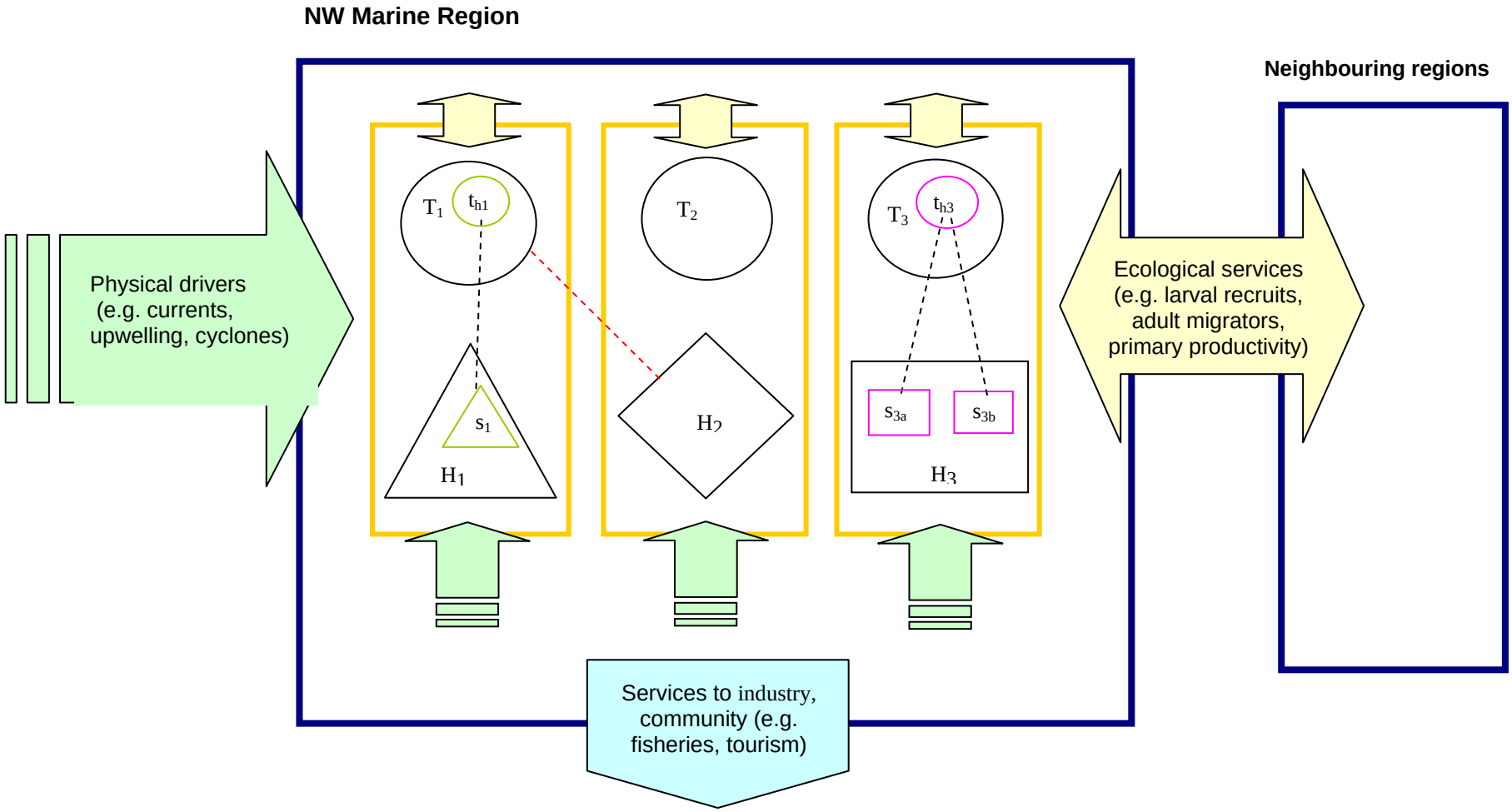

Figure 4-1 Conceptual regionalisation model – illustrating the relationship between (i) the NWMR and neighbouring regions and (ii) three sub-regions, each comprising a major habitat type (H) and associated trophic system (T). Key sub-habitats (s) and their associated trophic systems (t) are also shown. The influence of physical drivers and flow of ecological services is also shown at the regional and sub-regional level.

4.4 CONCEPTUAL MODELS AND DIAGRAMS

Schematic trophic models and habitat diagrams have been used to help describe the trophic systems within the NWMR. In combination these figures depict a range of characteristics for each trophic system, including:

- the main functional groups within each trophic system;
- examples of the species from each functional group;
- the main environments and other 'important habitats' in each sub-region;
- the main physical drivers impinging on each sub-region;
- the main services exported from and imported into each sub-region; and
- an indication of the level of certainty we have in each of the components.

The models of the trophic systems are designed to display the main functional groups in each sub-region and their links, providing a snapshot of the trophodynamics within the sub-region (see trophic sub-regional template - Figure 4-2). Most of the sub-regions trophic systems are simplifications (of the real world) designed to capture key aspects of the sub-region that are different from its neighbours or have an important ecological role in the sub-region.

The generic trophic sub-regional template (Figure 4-2) describes both pelagic and benthic environments. A thermocline is shown separating the surface layer within which pelagic primary production supplies resources to secondary and tertiary consumers. Detritus supplies resources to the benthic environment and is either directly consumed by detritivores (pelagic or benthic) or benthic producers. These supply resources to benthic primary and secondary consumers, which may include bentho-pelagic species groups. The bentho-pelagic groups may also provide the interface between the benthic and pelagic systems. Physical processes operate on both environments. Linkages with the neighbouring sub-regions are illustrated in the top right through exchanges of services or movement of migratory species.

Some sub-regions were either relatively uniform in their habitat features or had no other habitat type that we thought warranted highlighting as an 'important habitat'. Additional features and habitats (likely to have different trophic processes) are described in the narrative only. This helps to keep the models both informative but simple enough to be easily interpreted.

The 'important habitats' were selected based on having several or all of the following features:

- substantially different from the most common habitat and trophic system in the sub-region;
- relatively high species diversity and/or biomass;

- relatively unique in the NWMR.

Habitat diagrams complement the trophodynamic models by providing a visual impression of the sub-region including their depth profile, physical processes, water masses and other influences on the trophic systems. Together we hope that the trophic models and habitat diagrams provide the reader with relatively comprehensive visual depictions of the main components and influences in these trophic systems.

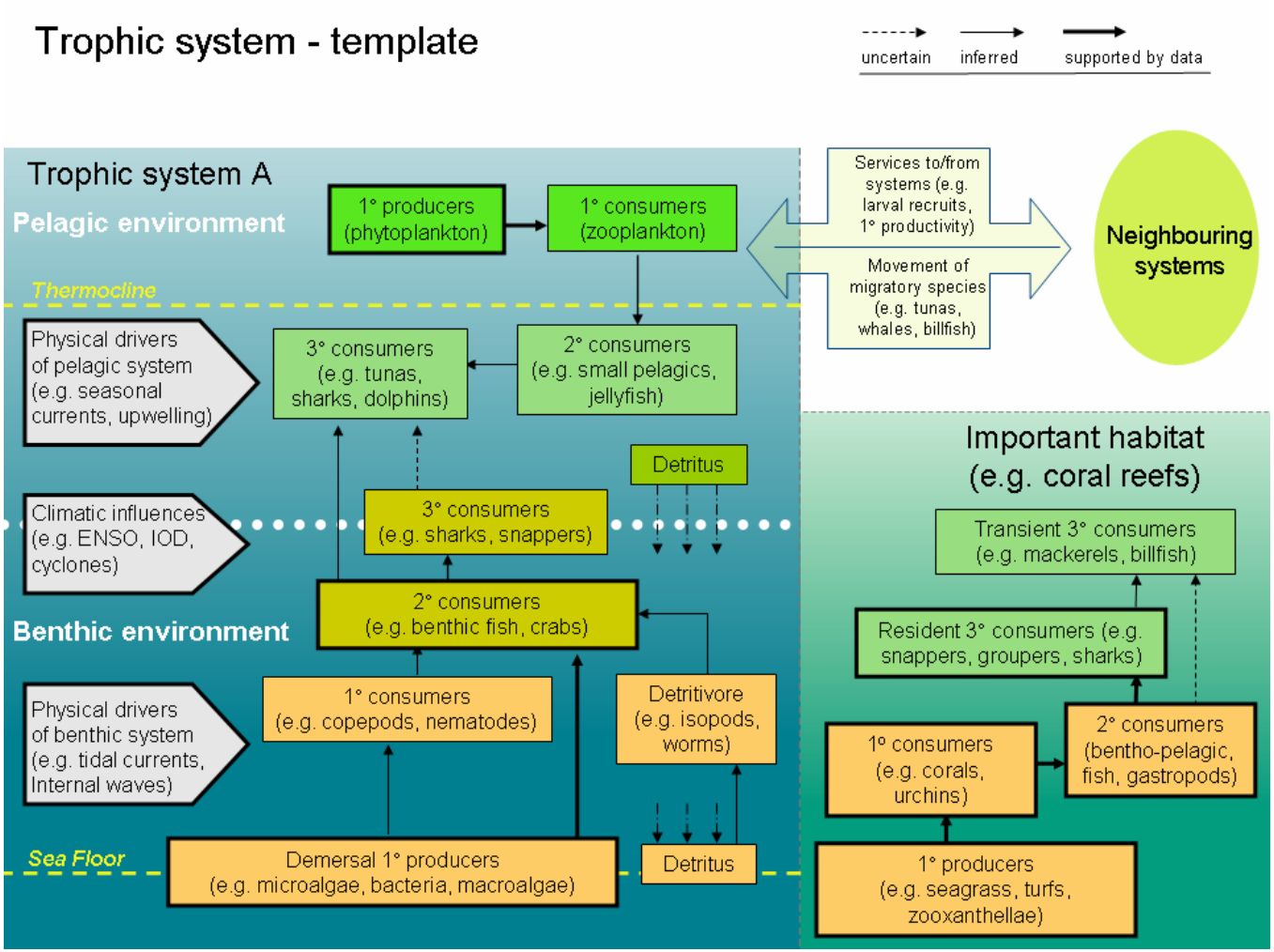

Figure 4-2 Template for schematics of the trophodynamics of each sub-region in the NWMR, showing the main functional groups, different environments, key ecological features of the system, physical drivers, and biological linkages and services between systems.