Conference attendance and presentations

M. Feng. Latitudinal response of the Leeuwin Current to inter-annual forcing using SODA re-analysis data, poster. session, 2006 Ocean Sciences Meeting., 20–24 February 2006, Honolulu, Hawaii, USA.

Publications and/or outcomes to date

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3.3.4 Ecological Interactions in Coastal Marine Ecosystems: Trophodynamics

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Note: This project commenced in 2005, and this report presents preliminary findings only.

Executive Summary

Two major seasonal field studies (Autumn and Spring 2005) have been completed for the Trophodynamics project, and work is well underway towards interpreting the food web dynamics of the Jurien Bay Marine Park region. Over 500 samples have been analysed for carbon and nitrogen isotopic signatures, with an initial focus on elucidating the grazing pathway (which includes seagrass, seagrass leaf epiphytes, brown algae, red algae, gastropods and sea urchins) for Autumn 2005.

We found a distinct isotopic separation of the seagrass/epiphyte group from the red and brown algae, although some overlap in $\delta^{13}C$ signatures between the brown and red algae makes

isotopic differentiation of these primary producers difficult. The grazing and detrital-feeding gastropods form a coherent group, which may be feeding primarily on brown algae with some inclusion of red algae; an additional scenario is that both red algae and seagrass (leaves and/or epiphytes) may form the diet of these gastropods. These preliminary results serve to highlight the need for further analyses using alternative biomarkers, and we will shortly move forward with fatty acid analysis of targeted samples using these C and N isotopic results as a guide.

An unexpected result was obtained for the sea urchin, *Phyllacanthus irregularis*, which was found to be heavily enriched in $\delta^{15}N$ above all organisms currently analysed (including rock lobster). Recent literature (Vanderklift *et al.*, 2006) indicates that this omnivorous urchin may consume a significant amount of sponges and ascidians in its diet, which we will test further when our samples for these filter-feeding organisms are analysed.

In addition to the field-based trophic work, preliminary studies on isotope enrichment have been undertaken using two species of cultured finfish. Interestingly, both species show a significant $\delta^{13}C$ enrichment of ~ 2.5 and 3 $^{o}/_{oo}$ as compared to their food source, challenging the standard assumption of minimal C enrichment between an organism and its food source, and indicating that we should be cautious with our interpretations of trophic relationships based on the presently accepted model. We are currently designing a series of aquaria experiments to more fully explore this issue and quantify the isotopic relationships between food sources and other key consumers in the marine environment.

Introduction

A three-year program to investigate ecological interactions in midwest coastal reef communities has been built around the Jurien Bay Marine Park (Figure 3.24), using multiple-use management zones within the park as large scale manipulations of predator abundance. This focus will gives the program an emphasis that distinguishes it from core SRFME projects and takes advantage of the unique opportunities developing in the midwest area. Two groups of predators, finfish and spiny lobster, are of primary interest and the zoning of the park, into areas subject to all kinds of fishing, lobster fishing only, and no-take restrictions, will facilitate the understanding of their respective ecological roles.

Outline

The key research/management questions that exist in the context of Ecological Interactions in the Midwest are as follows:

- What are the trophic linkages of exploited species to other ecosystem components?
- What are the pathways of transport of organic matter and nutrients between habitats and across the shelf?
- How do exploited species in particular utilize the range of available coastal shallow water habitats (e.g. foraging in seagrass, sheltering on reefs)?
- What are the potential trophic (indirect) effects of variations in predator density?
- What is the relative importance of any anthropogenic variation in ecological interactions relative to natural variability at the habitat, seasonal and interannual levels (e.g. can we detect indirect ecological effects of fishing against the background of natural variability)?
- How will populations of exploited predatory species respond to marine park protection (i.e. what are the direct effects of fishing)?

The goals outlined above will be achieved through an integrated research program involving state institutions, Universities and CSIRO. In order to maximize the information gained in the Midwest region, studies of ecological interactions can usefully be divided into the following sub-sections. These do not map directly onto the goals above, rather they provide a more practical framework through which to plan the research program.

1. Habitat characterization and benthic community biodiversity studies.
2. Studies of major predator groups - finfish
3. Studies of major predator groups - rock lobster
4. Trophodynamic studies.

Ultimately this suite of studies will allow reasonably detailed quantitative models of Midwest coastal ecosystems to be developed, through the input of underpinning data, as well as through an iterative process of validation and observation. Such models are currently being developed as part of SRFME core objectives and should begin coming online around the time that the Midwest Collaborative program is being completed.

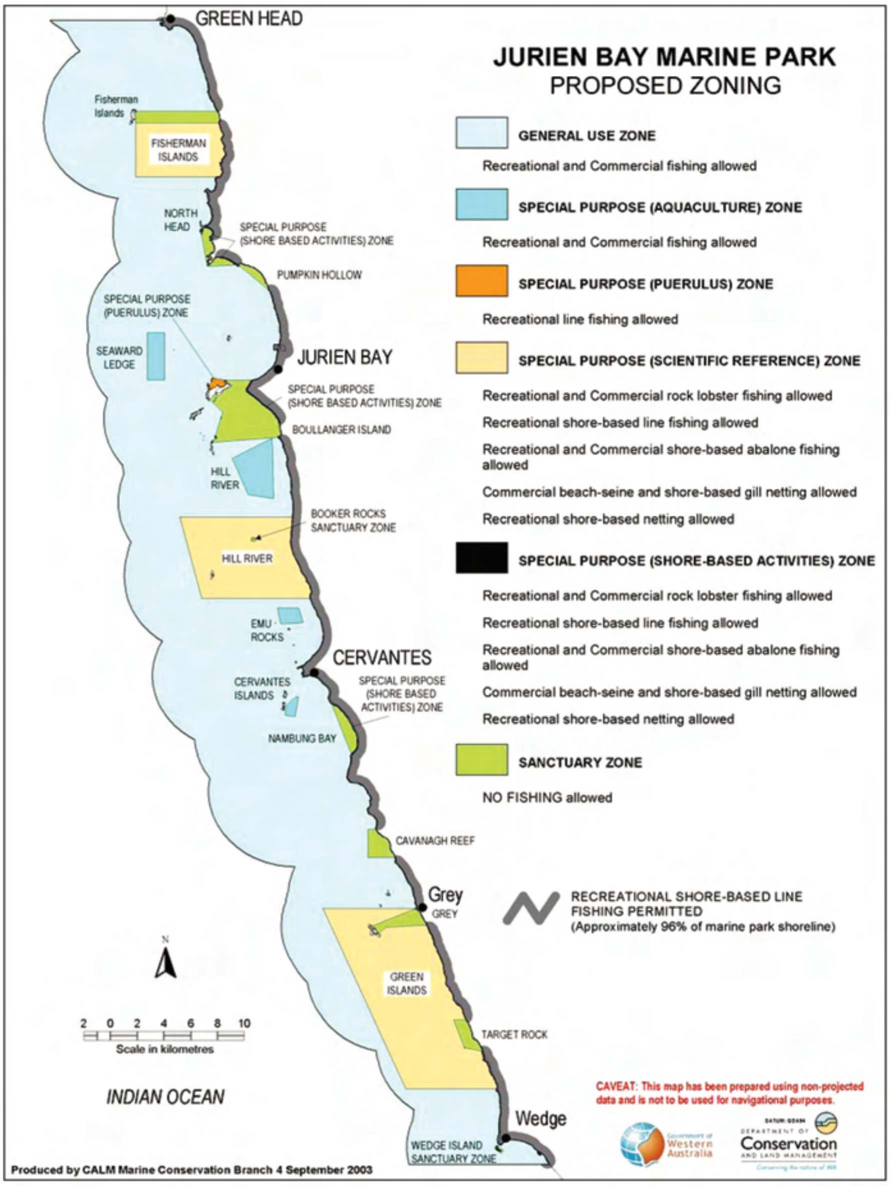

Figure 3.24: Map showing draft management zoning of the Jurien Bay Marine Park

Trophodynamic studies

Trophodynamic studies will mesh with other proposed and ongoing studies to provide a much better understanding of the flow of energy and nutrients at a range of spatial scales, from the small scale between habitats to larger cross-shelf scales. Studies on the dietary composition through gut content analyses of fish have traditionally been used to examine food webs and trophic linkages in aquatic ecosystems. However, such an approach rarely considers the ultimate source of energy and provides limited information on the interactions between the various primary producers and consumers in an ecosystem. Analyses of gut contents often provides only a snapshot of the diet of fish at a particular time, when the food consumed by fish often varies considerably over time (hours, days, seasons), during the life cycle of the fish (juveniles to adults) and among habitats (*e.g.* Werner and Gilliam 1984, Hyndes *et al.* 1997). Furthermore, different food types are digested at different rates, whereby hard-shelled prey can often be over-represented in gut-content analyses due to their recognisable fragments remaining in the guts for longer periods. In addition, the pharyngeal grinding of food by certain fish species renders the different food types consumed by these species indistinguishable.

Recently, researchers have recognised stable isotope techniques as a useful tool to identify and trace food/energy sources in coastal ecosystems (*e.g.* Kitting *et al.* 1984, Peterson and Fry 1987, Newell *et al.* 1995, Loneragan *et al.* 1997, Jennings *et al.* 1997, Pinnegar and Polunin 2000). This approach allows the linkages between fish and the various food sources in the coastal environment to be determined through measuring the natural isotopic ratios, typically $^{13}C/^{12}C$ and $^{15}N/^{14}N$, in the different primary producers and consumers. Since ^{13}C exhibits only slight enrichment in tissue from primary producers to the various consumer levels, $^{13}C/^{12}C$ typically is considered useful for tracing the source material in the food web (Peterson and Fry 1987). In comparison, ^{15}N displays a stepwise enrichment of approximately 3‰ between primary producer and each of the different consumer levels. The measurement of $^{15}N/^{14}N$ ratios has therefore been used to provide an estimate of the number of trophic levels in the food web (*e.g.* Fry and Quinones 1994). The combination of these isotopes provides a useful tool to examine the linkages among the various food sources and consumers in coastal environments and thereby provide an indication of the importance of different environments to major consumers.

Many important floral and faunal components of habitats are highly mobile, traveling large distances from one habitat to another. This transport includes the supply of drift algae or seagrass, as well as movements of reef-associated predators into other habitats to feed, or as part of seasonal foraging, ontogenetic or reproductive movements. By quantifying the abundance and origin of drift material, and by modeling the transport of algal and detrital particles we will begin to quantify the ecological linkages between habitats. Movement studies of key predatory species will provide information on the relative importance of different habitats for feeding and foraging. Biomarkers, particularly stable isotope ratios ($\delta^{13}C$, $\delta^{15}N$), will be used to validate and calibrate the relative magnitude of energy flows within the system, as well as the potential for habitat-related and ontogenetic differences in trophic relationships of key species such as lobster.

Objectives

The broad aim of this study is to examine the trophic linkages of different habitats within a coastal marine environment. This broad aim will be achieved through investigating the following specific objectives.

1. To determine the source of primary production that drives the food web for major consumers in a coastal marine environment using biomarker techniques;
2. To determine the spatial and temporal variability in the source of production for major consumers in a coastal marine environment; and
3. To determine the movement patterns of detached reef algae and seagrass into adjacent coastal marine habitats.

Methods

The study is split into two main subcomponents; (1) biomarker analyses; and (2) movement and biomass of wrack.

Biomarkers (stable isotopes)

Examining the diets of consumers has traditionally been used as a mechanism to study food webs in marine systems. However, dietary studies can underestimate the importance of some organisms to the food web due to their rapid digestion. Furthermore, dietary studies do not provide information on whether particular organisms are assimilated. It is therefore difficult to trace the origins of nutrients and energy using dietary approaches. Measurements of natural $^{13}C/^{12}C$ and $^{15}N/^{14}N$ isotopic ratios have been shown to be a useful tool for identifying and tracing the source of carbon and nitrogen in aquatic food webs (*e.g.* Kitting *et al.* 1984, Thresher *et al.* 1992, Newell *et al.* 1995, Loneragan *et al.* 1997, Marguillier *et al.* 1997). When an organism assimilates carbon and nitrogen from a source it either assimilates the isotopes indiscriminately, or displays a preference for one isotope (the fractionation ratio) for both carbon and nitrogen, thereby acquiring $\delta^{13}C$ and $\delta^{15}N$ that reflect the source. With the use of mixing models (*e.g.* Phillips & Gregg 2003), the $\delta^{13}C$ and $\delta^{15}N$ values of an organism can be used to infer the source of carbon and nitrogen it has assimilated, provided that the $\delta^{13}C$ and $\delta^{15}N$ ratios of all possible sources are known and differ to each other.

This component of the study will be split into two sections. The first phase of the study will examine the stable isotope signatures of a range of primary producers and consumers in a range of habitats in different regions of Jurien Bay. This part of the study will provide broad information on the flow of energy and nutrients in the food web of Jurien Bay. In other words, it will provide data on the contribution of the major primary producers to the food web of this marine system, and whether there are trophic linkages among different habitats. The second phase of the study will examine the spatial patterns in the influence of primary producers in unvegetated habitats and the extent to which primary producers from reefs and seagrass meadows influence the food web of unvegetated areas with increasing distance from those plant dominated habitats.

Broad trophic study

We propose to undertake detailed analyses of stable isotope signatures for rock lobster and selected finfish species with a view to gaining a better understanding of, not only how trophic relations vary among species, but also whether they vary ontogenetically due to changes in diet of individuals of increasing size. Habitat use may also vary ontogenetically, therefore we will explore variation in trophic signature between habitats and the possibility that isotopic signatures may be the result of the interaction between size and habitat.

The study will concentrate on collecting samples of consumers [finfish (e.g. Pink snapper) and major invertebrates (e.g. Western rock lobster)] from a range of dominant habitats in Jurien Bay, as well as collecting dominant primary producers (seagrasses and seagrass epiphytes, reef macroalgae, phytoplankton and benthic micro-algae) from the region. Since detritus is likely to form a major link in the food web, samples of different fractions of detritus will be collected to determine its composition in different regions of Jurien Bay.

Fish and invertebrates will be collected from reef, seagrass and unvegetated habitats in three regions of Jurien Bay using trawls or gill nets or by spearing. Where possible, this project will link into the dietary studies by MU, but additional samples may be required for the collection of adequate sample sizes. White flesh will be removed for stable isotope analyses. Macro-invertebrates will be collected through dive collections or coring. Flesh samples will be removed and stored for stable isotope analyses. Where invertebrates are too small to remove sufficient flesh, individuals will be pooled as one sample. Samples of live algae will be collected from reefs, and seagrass and epiphytic algae will be collected from seagrass meadows adjacent to reefs. Plants will be removed of any epiphytic material.

At least three replicate samples will be collected for each organism from each habitat and region. For major consumers, attempts will be made to collect samples from different size groups to examine ontogenetic shifts in stable isotope signatures. Since diets may vary seasonally, samples will be collected during two times of the year (summer/autumn and winter/spring).

Since $\delta^{13}C$ and $\delta^{15}N$ values among primary producers can be similar, alternative biomarkers may be required to allow differentiation of primary producers as sources for consumers. Sulphur isotopes have been shown to be useful to distinguish between benthic and pelagic food webs. For this reason, we will analyse sulphur isotope for target key benthic and pelagic species for these analyses.

All samples will be processed for $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios using an ANCA-NT/20-20 stable isotope ratio mass spectrometer at ECU. The $\delta^{13}C$ and $\delta^{15}N$ values will subsequently be calculated and compared using a multiple-source mixing model (e.g. Phillips and Gregg 2003). For targeted species, samples will be processed for sulphur and sent to other facilities for analyses.

Many studies have used the assumption that $\delta^{13}C$ displays minimal enrichment while $\delta^{15}N$ displays a stepwise enrichment (3-5 ‰) between different trophic groups. However, this can be highly variable among different organisms, particularly for $\delta^{15}N$ (Vanderklift and Ponsard 2003). Interpretation of stable isotope data requires information on the enrichment of both $\delta^{13}C$ and $\delta^{15}N$ through the various trophic steps. However, there is limited information available on enrichment of these isotopes for the organisms that will be examined in this study. We therefore propose to carry out a series of experiments to examine the trophic enrichment of $\delta^{13}C$ and $\delta^{15}N$ and sulphur exhibited by some major consumers.

Selected invertebrates will be placed in aquaria and provided with food for which the $\delta^{13}C$ and $\delta^{15}N$ values are known. Consumers will be kept in the aquaria for up to two months to ensure that SI signatures derived from their existing diet has been replaced by that derived from their new diet. At the end of the experiments, consumers will be removed from the aquaria, euthanased and flesh removed for SI analyses. Differences between the $\delta^{13}C$ and $\delta^{15}N$ values will indicate the level of enrichment (or depletion). For fish and large macro-invertebrates, the turnover of $\delta^{13}C$ and $\delta^{15}N$ in the flesh is likely to occur over an extensive timeframe, thereby limiting any opportunity to carry out aquaria experiments to examine enrichment in these organisms. We therefore propose to collaborate with personnel at the TAFE Maritime Centre, where fish are being reared in captivity. We will examine the $\delta^{13}C$ and $\delta^{15}N$ of a suite of fish species (e.g. Pink snapper, Black bream and Dhufish) and their food source.

Spatial influence

As previously noted, trophic studies using stable isotopes are useful when the SI signatures of the various primary producers are widely disparate. Current work at ECU (G. Hyndes and P. Lavery) is showing that the seagrasses *Posidonia* spp. and *Amphibolis* spp. have highly enriched $\delta^{13}C$ values relative to algal species. However, the SI signatures of brown, red and green algae are relatively similar to each other, making it difficult to distinguish these groups as potential sources. The second phase of the stable isotope study will therefore attempt to fill some of the gaps that have become event from the broad stable isotope study. Potentially, by the end of Phase 1, we will not have a clear understanding of the principal sources of C and N in unvegetated areas that are adjacent to reefs and seagrass meadows, yet the transport of material from these other major benthic habitats is likely to provide significant production into these unvegetated areas.

The second phase of the study (year 2) is likely to focus on examining the change in stable isotope signatures in the benthic infauna and epibenthic fauna in unvegetated areas with increasing distance away from seagrass meadows and reefs. A current study by Mat Vanderklift is examining the hypothesis that $\delta^{13}C$ in seagrass fauna should change gradually with distance from reef, reflecting the gradual change in the relative importance of reef-derived macroalgae and seagrass. The proposed study will expand on this hypothesis by examining the hypothesis that $\delta^{13}C$ in fauna associated with unvegetated areas should change gradually with distance from reef and seagrass meadows, resulting from a shift in the relative importance of reef-derived macroalgae and seagrass.

Artificially enriching either the $\delta^{13}C$ or $\delta^{15}N$ of some of the major primary producers may be required to provide a clear demarcation of the SI signatures of those sources that will allow SI signatures to be tracked along transects away from reefs or seagrass meadows. Alternatively, other biomarkers, such as sulphur, fatty acids or amino acids, may be required to fulfill this task. Results from current preliminary work at CSIRO and ECU will be used to help direct and refine this part of the project.

Movement and biomass of wrack

Accumulations of wrack are a prominent feature of the coastline of south-western Australia. Algae from reefs and seagrasses and their associated epiphytic material become dislodged, particularly during winter storms, and are transported into adjacent habitats. It has been estimated that approximately 20% of production from reefs and seagrass meadows passes through the nearshore regions (Hansen 1984), where it has been shown to provide important habitats for a range of invertebrates and finfish species (Robertson & Lenanton 1984, Lenanton et al. 1981). Currently, a SRFME PhD study at ECU (K. Crawley) is further examining the importance of this wrack material to the habitat structure and trophic dynamics of nearshore waters in the Perth metropolitan region. This study is showing that fish species have a clear preference for particular volumes and types of wrack and that prey species have a clear preference for brown algae as a food source.

We plan to examine the movement patterns of wrack from reef and seagrass meadows into subtidal, unvegetated areas in Jurien Bay. The transport of this material is likely to contribute significantly to secondary production in these areas. We will also examine the biomass and composition of wrack material in these areas. This will be achieved through:

- Stratified random design using towed video transects, and ground truthing using large quadrats to quantify the volume/biomass of different wrack types in different regions during different times of the year. Sampling will be conducted over at least four (seasonal) sampling occasions.
- Tracking of wrack using either acoustic tags and receivers for tracking the movement of wrack, or using conventional tags or colour-dyed plant material and towed video transects to record presence of “tagged” material in adjacent unvegetated areas. The acoustic tagging approach will be dependent on the success of additional proposals to gain funds for this part of the study.

Results and Discussion

To date, we have successfully carried out the two major seasonal field studies to examine broad trophodynamics relationships within the Jurien Bay Marine Park. These were completed in autumn (April/May) and spring (October) 2005. During each field trip, sediment, seagrass, algae and invertebrate samples were collected at eight sampling sites within the Jurien Bay and Green Head regions (Fig. 3.25). These sites are subjected to different exposure regimes (i.e. inshore versus mid-shelf) and levels of marine park protection (i.e. fished versus sanctuary zones), as detailed in Table 3.3.

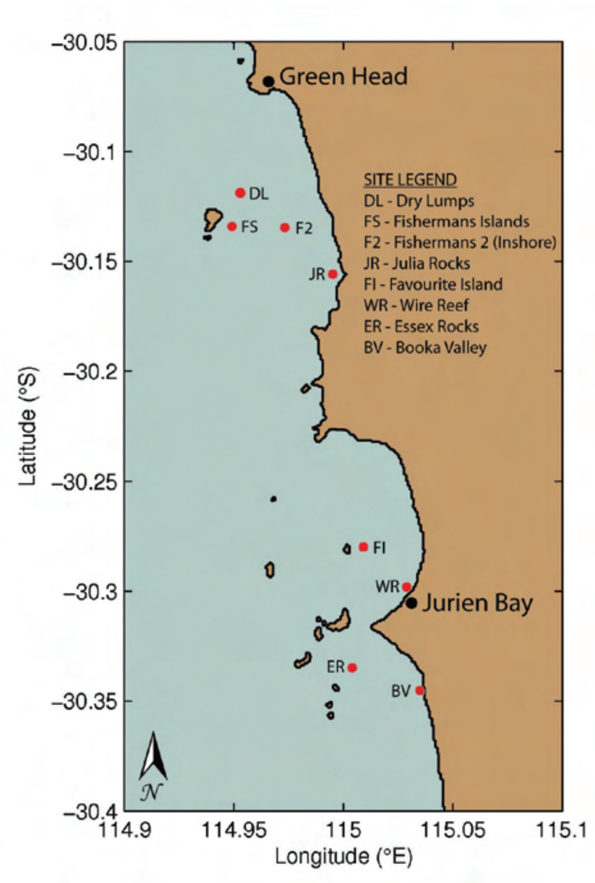

Figure 3.25: Location of the eight sampling sites for the Trophodynamics project within the Green Head and Jurien Bay regions.

Table 3.3. Details of the eight sampling sites within the Green Head and Jurien Bay regions.

Region	Location	Zoning Type	Site	Label	Latitude (S)	Longitude (E)
Green Head	Mid-shelf	Fished	Dry Lumps	DL	30°07.130'	114°57.179'
Green Head	Mid-shelf	Sanctuary	Fishermans Island	FS	30°08.050'	114°56.952'
Green Head	Inshore	Sanctuary	Fishermans 2	F2	30°08.080'	114°58.406'
Green Head	Inshore	Fished	Julia Rocks	JR	30°09.352'	114°59.712'
Jurien	Mid-shelf	Fished	Favourite Island	FI	30°16.805'	115°00.552'
Jurien	Inshore	Fished	Wire Reef	WR	30°17.887'	115°01.731'
Jurien	Mid-shelf	Sanctuary	Essex Rocks	ER	30°20.085'	115°00.246'
Jurien	Inshore	Sanctuary	Booka Valley	BV	30°20.723'	115°02.250'

Laboratory work has concentrated on carbon and nitrogen isotopic analyses of samples collected from the autumn field trip. Approximately 500 samples have been analysed to date. We have concentrated first on the elucidation of the grazing pathway, with priority analysis of seagrass, seagrass leaf epiphytes, brown algae, red algae, gastropod and sea urchin samples.

As displayed in Figure 3.26, in the autumn samples there is a distinct separation between the seagrass/epiphyte group and the red and brown algae, with the seagrass and leaf epiphytes more enriched in $\delta^{13}C$. The brown algae has overlapping $\delta^{13}C$ signatures with three species of red algae (*Hypnea* sp., *Laurencia filiformis* and *Metamastophora flabellata*; Fig. 3.26), making isotopic differentiation of these primary producers difficult. The grazing and detrital-feeding gastropods form a coherent group that is enriched in $\delta^{15}N$ compared to the brown algae, and near the upper distribution of $\delta^{15}N$ for the red algae. There is a general overlap in $\delta^{13}C$ signatures between these gastropods and both the brown and red algae. These results indicate that this group may be feeding primarily on brown algae with some inclusion of red algae; an additional scenario is that both red algae and seagrass (leaves and/or epiphytes) may form the diet of these gastropods, resulting in an intermediate $\delta^{13}C$ signal between these two plant groups. This $\delta^{13}C$ overlap between primary producers is not unexpected given previous research in this area, and serves to highlight the need for further analyses using alternative biomarkers. We will shortly move forward with fatty acid analysis of targeted samples using these C and N isotopic results as a guide.

These analyses also highlighted three species with enriched $\delta^{15}N$ signatures compared to the algal and seagrass material (Fig. 3.26), which includes one species of carnivorous gastropod (the whelk *Thais orbita*) and two species of reef-dwelling sea urchins (*Heliocidaris erythrogramma* and *Phyllacanthus irregularis*). *Thais orbita* is known to prey on other gastropod species, and its ~ 3 $^{o}/_{oo}$ $\delta^{15}N$ enrichment and similar $\delta^{13}C$ signature to the grazing gastropods provides further evidence of its trophic status. The two sea urchin species exhibit $\delta^{13}C$ signatures that are most similar to the brown algae and some of the grazing gastropod species. With the $\delta^{15}N$ signature, *H. erythrogramma* is enriched ~ 3 $^{o}/_{oo}$ as compared to the brown algae, as expected for a grazing species approximately one trophic level above these primary producers. However, *P. irregularis* was measured at a further ~ 3 $^{o}/_{oo}$ $\delta^{15}N$ enrichment above *H. erythrogramma*. Isotopic analysis of rock lobster (*Panulirus cygnus*) has also been undertaken as part of the 'Ecological Interactions in Coastal Marine Ecosystems: Rock Lobster', and is presented in the accompanying progress report for that study. It is notable that the $\delta^{15}N$ signatures for the various rock lobster samples are also lower than that of *P. irregularis*. We expect, based on the recent work of Vanderklift *et al*. (2006), that this surprising result can be explained by the unique diet of *P. irregularis* as compared to other local urchin species. *Phyllacanthus* was found to be an omnivore which, in addition to a diet of macroalgae, consumed significant amounts of animal tissue, specifically sponges and ascidians. Vanderklift *et al*. (2006) also found that *P. irregularis* had an enriched $\delta^{15}N$ signature which ranged between ~ 9 and 13 $^{o}/_{oo}$.

We have also examined the differences in isotopic signatures between these two urchin species by location (Fig. 3.27), and found that $\delta^{15}N$ enrichment of *P. irregularis* is consistent throughout the study area. Of particular note, however, is the pattern of $\delta^{13}C$ depletion for both *P. irregularis* and *H. erythrogramma* between sites in the Jurien Bay region. For both of these species, the $\delta^{13}C$ signature shows the trend Wire Reef (WR) > Booka Valley (BV) > Favourite Island (FI). To determine if this is a reflection of different $\delta^{13}C$ signatures of the primary producers at these sites, we examined isotopic results for a variety of brown and red algae species by site. These results (not shown) indicated no coherent site-specific pattern in C or N isotopic signatures, and thus could not provide support for the trend in $\delta^{13}C$ observed with the sea urchins. We expect that analysis of the additional faunal samples obtained (especially sponge and ascidian samples) may help explain the observed pattern, at least for *P. irregularis*.

In addition to the field-based trophic study described above, preliminary studies on isotope enrichment have been undertaken to examine the common assumption that between different trophic groups, $\delta^{13}C$ displays minimal enrichment (0 - 1 $^{o}/_{oo}$) while $\delta^{15}N$ displays a stepwise enrichment of approximately 3 – 5 $^{o}/_{oo}$. We have begun this study by examining enrichment in two species of cultured finfish, snapper (*Pagrus auratus*) and mulloway (*Argyrosomus japonicus*). Five replicate specimens of each species were obtained from the TAFE Maritime Centre. These fish were approximately 1 year in age, and had been fed exclusively on a diet of food pellets (composed largely of fish meal, fish oil, wheat and plant protein meal).

Results from isotopic analysis of fish muscle tissue and triplicate samples of small food pellets (fed to snapper and mulloway) and large food pellets (fed to mulloway only) are displayed in Figure 3.28. Both fish display ~ 3 $^{o}/_{oo}$ $\delta^{15}N$ enrichment above their food source, which matches the common assumption used in trophic studies. However, both the mulloway and snapper also show a significant $\delta^{13}C$ enrichment of ~ 2.5 and 3 $^o/_{oo}$, respectively. This challenges the standard assumption of minimal C enrichment, and highlights that we should be cautious with our interpretations of trophic relationships based on the currently accepted model. Given this important result, we will continue to move forward with our isotope enrichment experimental studies and will now focus on exploring the relationships between food sources and other primary consumers.

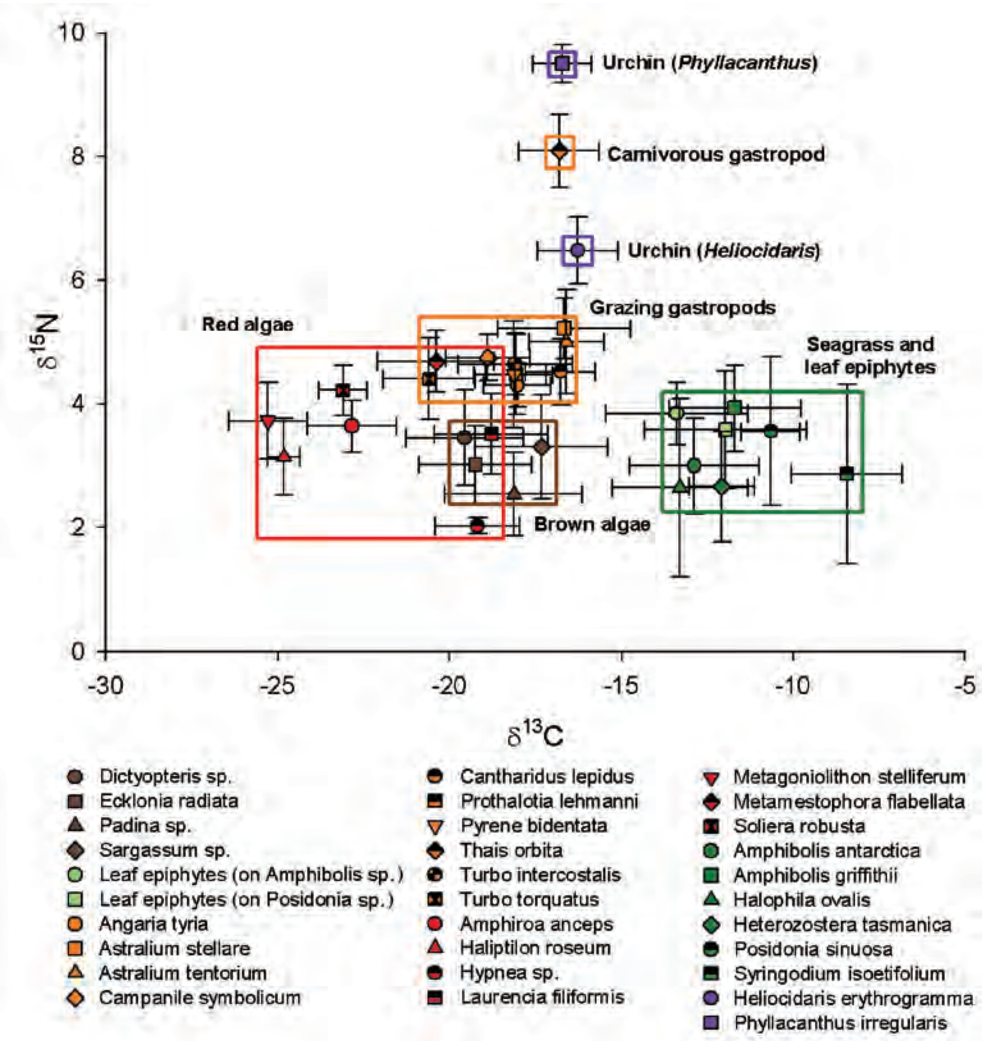

Figure 3.26: Isotopic analyses of seagrass, algae, gastropod and sea urchin samples collected in Autumn (April/May 2005) from all sites within the study area; values are mean ± s.d.

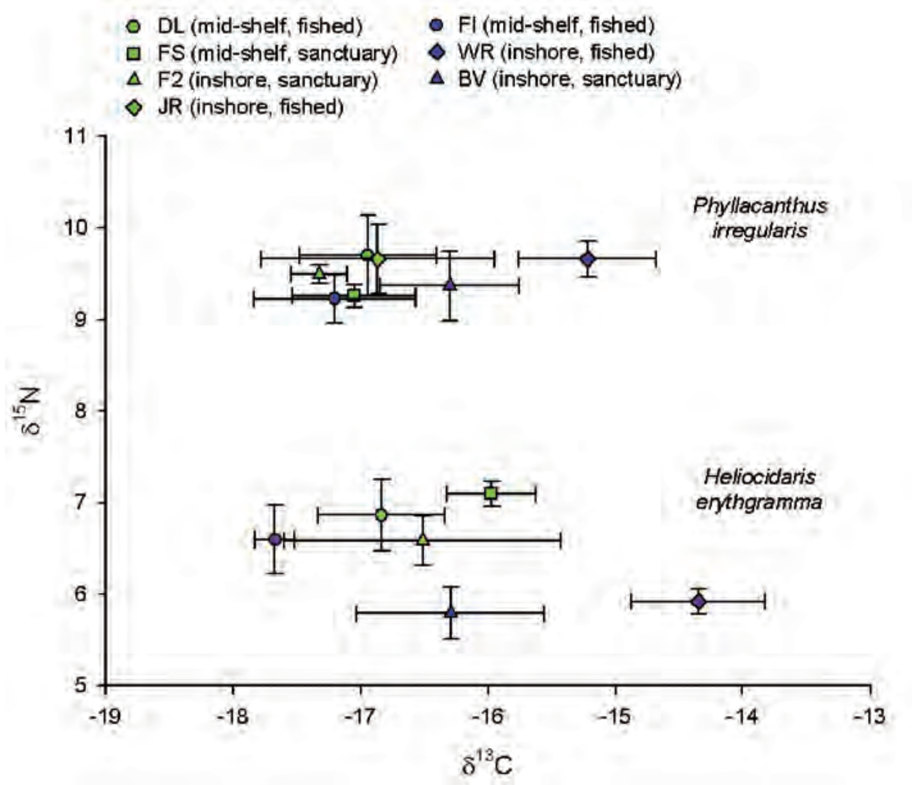

Figure 3.27: Isotopic analyses of two reef-dwelling sea urchin species by site within the Green Head (green markers) and Jurien Bay (blue markers) regions. Values are mean ± s.d.

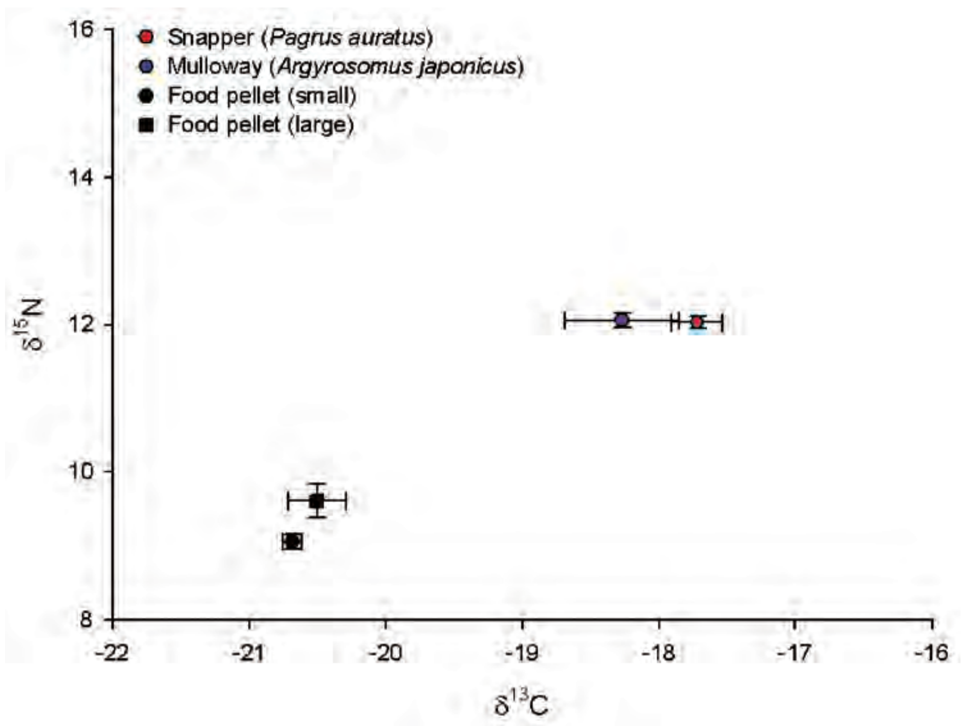

Figure 3.28: Isotopic analyses of tissue samples from two fish species that had been fed on an exclusive diet of food pellets for approximately 1 year. The snapper were fed on the 'small' pellets, while the mulloway were given a mixture of 'small' and 'large' pellets. Values are mean ± s.d.

Our upcoming research agenda focuses on the completion of laboratory processing and analysis of all remaining samples from the autumn and spring 2005 field trips. After the results from the broad trophic study have been interpreted, we will finalize the sampling design and methods for the second phase of the stable isotope study. The other main agenda item is the design and execution of the experimental isotope enrichment work for key consumer species. This work will be carried out in aquaria at ECU and, where required, at the WA Fisheries labs in Watermans. We are currently designing the experimental plan and, based on the preliminary isotopic analysis, identifying which invertebrate species to concentrate our efforts on.

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Conference attendance, presentations, publications and/or outcomes to date

At this early stage in the Trophodynamics project, work has concentrated on the successful execution of the two major field studies of trophic relationships within Jurien Bay Marine Park, and on the laboratory processing and analysis of samples from this field work. We are now in a position to start examining and presenting preliminary results, and this will be the focus of our future dissemination efforts.

Plans for 2006 include:

- Presentation of the Trophodynamics project outline and preliminary results at the University of Nice, France and the Dauphin Island Sea Lab, USA.
- Assisting in the organisation of, and participating in, a Jurien Bay Marine Science symposium day, to be held in Jurien Bay in conjunction with CALM. This will assist in informing the local park managers, fellow Jurien-based researchers and general public of the Trophodynamics project and its significance for the region.
- Presentation of preliminary results at the SRFME Core and Collaborative Projects Symposium, held at CSIRO.
- Presentation of the Trophodynamics project outline and preliminary results at the Centre for Ecosystem Management (CEM) Seminar Series, held at ECU.
- Creation of a large poster detailing the Trophodynamics project, including preliminary results and future plans, to be displayed at ECU and other venues where appropriate.
- Project outline and preliminary results to be posted on a Trophodynamics project webpage within the Coastal Marine Ecosystem Research (CMER) website, based at ECU.

3.3.5 Ecological Interactions in Coastal Marine Ecosystems: Rock Lobster

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