California MLPA Master Plan Science Advisory Team
Responses to Science Questions Posed by the NCCRSG at its August 22-23, 2007 Meeting

Revised February 19, 2008

The following are responses of the MLPA Master Plan Science Advisory Team (SAT) to questions posed at the August 22-23, 2007 meeting of the MLPA North Central Coast Regional Stakeholder Group (NCCRSG). These responses have been prepared by work groups of the SAT and adopted by the SAT at various meetings.

1. **Are the deep water benthic habitats and water column habitat around the Farallon Islands unique as well as worthy of inclusion?**

   This response was adopted by the SAT at its October 1, 2007 meeting.

   Response: The SAT has identified the intertidal, subtidal, and water column habitats around the Farallon Islands as unique. (Please refer to the response to Question 2 from the list of questions from the NCCRSG July 10-11, 2007 meeting.) Habitats that are unique are, according to the regional goals and objectives, worthy of inclusion.

2. **Specifically – where does the subtidal start? For MLPA purposes does it only span to the extent of state waters or does it extend to XX depth (and if so what depth)?**

   This response was adopted by the SAT at its October 1, 2007 meeting.

   Response: The subtidal includes all habitats deeper than the mean lower low water level, including state, federal, and international waters (Please refer to the response to Question 2 from the list of questions from the NCCRSG July 10-11, 2007 meeting).

3. **What level of protection would you assign to marine protected areas (MPAs) that allow take of salmon, abalone, urchin, clams, *halibut, white seabass, and crab*?** (Mark Carr, Ray Hilborn)

   Response: This response is incorporated in the document, *Draft MLPA Evaluation Methods for MPA Proposals in the North Central Coast Study Region*.

4. **What is range and pattern of movement for the various life-stages of yellow-eye rockfish, surfperch, greenling, cabezon, [monkeyfaced prickleback (a.k.a. monkeyfaced eel, *Cebidichthys violaceus*)] and [rock prickleback, (*Xiphister mucosus*)], halibut, and white seabass?** (Mark Carr, Jan Freiwald)

   This response was adopted by the full SAT at its November 13, 2007.

   Response: A literature review conducted by Jan Freiwald shows that 75% of tagged individuals of the following species moved less than 0.5 km during the respective study periods which ranged in duration. Though the study periods varied, there was no significant relationship between the time individuals were at large and the distance they traveled.

   - yellow-eye rockfish (*Sebastes ruberrimus*)

- surfperch (*Embiotoca jacksoni* and *E. lateralis*)
    - o Both of these species primarily occupy rocky and kelp habitats. Surfperches that occupy other habitats may move different distances.
- greenling (*Hexagrammos decagrammus*)
- cabezon (*Scorpaenichthys marmoratus*)
- monkeyface prickleback (*Cebidichthys violaceus*)*

* the study on monkeyface prickleback movement was excluded from the literature review analysis because fewer than 10 individuals were tagged. However, all tagged individuals moved less than 3 kilometers.

The SAT was unable to find information on the movement of rock prickleback or white seabass.

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California Halibut (Paralichthys Californicus)

Tagging studies of California halibut indicate that the majority of individuals remain in a localized area for extended periods of time, while others move long distances along the coast (Domeier and Chun 1995, Posner and Lavenberg 1999). In the Posner and Lavenberg study, 65% of recaptured halibut were recaptured within 5.5km of their release site (this is the highest resolution of movement provided by the data). In the Domeier and Chun study, 60% of recaptured halibut moved less than 2 km during the study period. The authors note that most recaptured fish were at liberty for fewer than 100 days likely due to a high rate of tag loss, however even within that 100 days, some individuals moved more than 300 km.

Any distinctions between adult and juvenile patterns of movement are still unclear, as few of the halibut in these tagging studies were larger than the sport fishery size limit of 56 cm total length (17% in the Domeier and Chun, only 3% in Posner and Lavenberg) In the Domeier and Chun study, halibut larger than 50 cm (approx 30% of sample size) tended to travel markedly greater distances than halibut smaller than 50 cm.

A study focusing on juvenile California halibut settlement revealed preference either for bays or the open coast. However, almost all coastal settlers entered and used the bays as nursery areas during their first year of life, or else they died (Kramer 1991).

References

Domeier, ML and CSY Chun 1995. A Tagging Study of the California Halibut (Paralichthys Californicus). California Department of Fish and Game, CalCOFl Rep., Vol. 36

Kramer, SH 1991. Growth, mortality, and movements of juvenile California halibut Paralichthys californicus in shallow coastal and bay habitats of San Diego County, California. Fishery Bulletin 89(2) 195-207

Posner, M and RJ Lavenberg 1999. Movement of California halibut along the coast of California. California Fish and Game, Vol. 85(2) 45-55

5. **In the MLPA Central Coast Study Region the recommendation to extend MPAs to the three mile state water limit to cover the range of depths and species that utilize the range of depths made sense but the north central coast study region is largely homogenous out to the three mile limit, so does it still require MPA extension to the three mile state water boundary?**

This response was adopted by the SAT at its November 13, 2007 meeting.

Response: The SAT recommends that MPAs be designed to extend from the intertidal to the boundary of state waters to encompass the depth-related movements of various species across the range of depths in state waters. The SAT recommends that MPAs in the 30-100 m depth range encompass as much of this depth range as possible out to the boundary of state waters, thereby protecting the collective number of species that occur there and accommodate their depth-related migrations. In the case that the habitat is homogeneous (uniform substrate and uniform depth ±5m) across a broad area, MPAs should be designed to encompass adult neighborhood sizes and movement patterns in both alongshore and cross-shore directions. In the design guidelines, the SAT recommends that MPAs span a minimum of 3 miles alongshore to encompass adult movement patterns. In cases where habitat is homogeneous across a broad area, adults are likely to extend their movement in both alongshore and cross-shore directions, therefore MPAs should also extend a minimum of three miles seaward (towards the state waters boundary) to encompass these movements. The SAT notes that extending MPA boundaries to the edge of state waters has the added benefit of allowing for connections with possible future MPA designations in federal waters.

(For additional information please refer to the response to Question 4 in the list of questions from the NCCRSG July 10-11, 2007 meeting.)

6. How do you evaluate proposals relative to Goal 2, Objective 2 for the protection of foraging, nursery and rearing areas?

   a. Specifically, also considering seabirds, mammals, and sharks.

This response was adopted by the SAT at its November 13, 2007 meeting.

Response: (Question 6) Fish and invertebrates use habitats already named in the master plan for MPAs goals and objectives (such as estuaries and kelp forest/rocky reefs) for their foraging, nursery, and rearing activities. Therefore, evaluating proposals for protection of these habitats will suffice to evaluate protection of foraging, nursery and rearing areas for most fish and invertebrate species.

Response: (Question 6a – reference to sharks) An analysis of available information about shark breeding, forage, and nursery areas indicates that sharks largely use habitats already named in the master plan for MPAs goals and objectives (such as estuaries and soft bottom) for these activities (see table below). Therefore, evaluating proposals for protection of these habitats will suffice to evaluate protection of foraging, nursery and rearing areas for most shark species in the study region. The special importance of estuarine habitats for certain species of shark should be noted. Proposals that protect a high proportion of the available estuarine habitats will be especially protective of these species.

Common Name	Sci. Name	Forage areas	Breeding areas	Nursery areas

Common Name	**Sci. Name**	**Forage areas**	**Breeding areas**	**Nursery areas**
Sevengill shark	*Notorynchus cepedianus*	SFB	SFB birthing	SFB
Spiny dogfish	*Squalus acanthias*	SFB	(season: Sept-Jan)	young occupy pelagic
Angel shark	*Squatina californica*	soft flat bottoms near vertical relief	unknown	unknown
Basking shark	*Cetorhinus maximus*	near-surface filter feeders: areas of abundant plankton	unknown	thought to be in plankton-rich oceanic waters at higher latitutdes and far away from coastal areas
White shark	*Carcharodon carcharias*	Farallons, Bodega Headlands, Ano Nuevo	unknown	warm-temperate areas
Leopard shark	*Triakis semifasciata*	SFB, Tomales, Drakes Estero	(in spring) SFB birthing within eel grass beds	SFB, Tomales, Drakes Estero
Brown smoothhound shark	*Mustelus henlei*	SFB, Tomales	unknown	SFB, Tomales
Soupfin shark	*Galeorhinus galeus*	demersal and pelagic	(in spring)	SFB, Tomales (# has declined to since fishery of 30's-40's, still under historic levels)
Torpedo ray	*Torpedo californica*	sandy bottoms, near kelp beds, around rocky reefs	unknown	unknown
Big skate	*Raja binoculata*	coastal benthic	unknown	unknown
California skate	*Raja inornata*	nearshore soft bottom benthic	unknown	unknown
Longnose skate	*Raja rhina*	on or near reefs with vertical relief	unknown	unknown
Starry skate	*Raja stellulata*	nearshore benthic	unknown	unknown

Common Name	Sci. Name	Forage areas	Breeding areas	Nursery areas
Bat ray	*Myliobatis californicus*	SFB, Tomales, Drakes Estero	unknown	SFB, Tomales, Drakes Estero
White-spotted chimaera	*Hydrolagus colliei*	benthic mud or cobblestone near vertical relief	(maximum spawning during spring and summer) egg cases deposited on mud or gravel substrate	Cordell Banks
Salmon shark	*Lamna ditropis*	Nearshore to deep oceanic waters, from the surface to depths of 375m	Ovoviviparous, breeding occurs in fall and birthing in late spring (2-4 pups); gestation is believed somewhat less than one year	Central California is the most common area for ages zero and one; selected nursery areas offer rich feeding and relatively few potential predators

Response: (Question 6a – reference to birds and mammals) This response is incorporated in the document, *Draft Evaluation Methods for MPA Proposals in the North Central Coast Study Region*.

7. Provide an estimate of number of pinnipeds in the area and an estimate of weight of fish taken.
   a. Also want to know what impacts range expansion of Humboldt squid has and how that should be considered.

This response was adopted by the SAT at its November 13, 2007 meeting.

Response: (Question 7) Five pinniped species commonly occur in the north central coast study region: harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), northern fur seals (*Callorhinus ursinus*), and northern elephant seals (*Mirounga angustirostris*). Of these species, only harbor seals are year-round residents; other species visit the region seasonally or are migratory through it. Peak abundance estimates for these species in the NCCSR are:

Harbor seals: ~8000—during the breeding season

California sea lions: ~2000—most are male winter visitors to the study region

Steller sea lions: ~250—southern limit of the species, with small breeding colonies in the study region

Northern fur seals: ~250—this species migrates through the region primarily offshore of state waters, but there is a small breeding population at the Farallons

Northern elephant seals: ~3000—migratory and present in the study region during breeding and molting seasons, likely do not feed in the area

These numbers are the best available average peak population estimates, and actual numbers can vary greatly. Furthermore, abundances and behaviors vary among seasons and among species. Population fluctuations and seasonal variation in feeding intensity make it difficult to provide accurate estimates of the total weight of fish taken in the study region. Current estimates are that actively feeding pinnipeds consume from 4% to 10% of their body weight each day, with an average of 6%. Juveniles and pregnant females consume a higher percentage of their body weight than non-pregnant adults. It is important to note that not all pinnipeds are actively feeding during the breeding season. Also, many pinnipeds target juvenile or mid-sized fish, not large mature individuals. Average pinniped body size and a rough estimate of the weight of fish consumed daily are presented in Table 1.

Table 1

Species	**Avg. Female (lbs)**	**Avg. Male (lbs)**	**Weight of prey consumed (lbs/day)**	**Prey species**
Harbor Seal	180	180	10	Fish, squid, octopus
Cal. Sea Lion	180	600	10-35	Fish, squid, octopus
Steller Sea Lion	580	1250	30-75	Fish, squid, octopus
Northern Fur Seal	100	525	10-30	Small fish, invertebrates

Northern elephant seals likely do not feed in the area, instead migrating to Alaska and the north Pacific gyre to feed.

References

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Personal communication: Sarah Allen (Point Reyes National Seashore), Beth Phillips (Marine Wildlife Veterinary Care and Research Center), Jacquie Hilterman (The Marine Mammal Center, and Dede Sabbag (The Marine Mammal Center).

A similar question was asked during the central coast process. That question and response are provided below:

Question: What are historic and recent population trends (spatial and temporal) of marine mammals (sea lions, harbor seals and sea otters specifically)? What are their diets? What is the impact of their feeding on commercially and recreationally important species?

Efforts to protect and rebuild marine fish and shellfish populations within marine protected areas by restricting or prohibiting fishing may be undermined by consumption of species of concern by top-end predators, chiefly marine mammals. Some stakeholders believe that the effect of such predation should be evaluated and, where possible, steps taken to address possible impacts of top end predators on MPAs.

Relation to the MLPA and MPF (Master Plan Framework) and Other Relevant Law: The MLPA and the MPF are silent on the impact of marine mammals and other top-end predators. Predation by marine mammals is not one of the major threats identified in the Act. Nor does the act single out particular species or groups of species. Instead, the Act focuses upon ecosystems. Passage of the Marine Mammal Protection Act in 1972 and the Endangered Species Act in 1973 pre-empted the management authority of individual states over marine mammals and species listed under the Endangered Species Act. With few exceptions, both Acts prohibit the taking of species under their jurisdiction. Taking includes intentional and unintentional hunting, harm, harassment, or injury. Under the ESA, these prohibitions may be extended to species listed as threatened, as they have been for the southern sea otter. Exemptions to these prohibitions are very limited, generally to taking by Native Americans for certain purposes, taking for scientific research, public display, or enhancement, or taking incidental to commercial fishing or other non-fishing activities. The regulatory requirements for the use of these exemptions are very rigorous.

Both the Endangered Species Act and the Marine Mammal Protection Act emphasize the role of marine mammals, and other species, in maintaining healthy ecosystems. Similarly, the MLPA takes an ecosystem-based approach, rather than an ecosystem management approach, which would suggest that we have the knowledge and experience to manage ecosystems through manipulation of species.

Recommendation: Below, Initiative Staff have provided a summary of available information on population trends and diets of California sea lions, harbor seals, and southern sea otters. While the California sea lion population continues to grow, harbor seal and southern sea otter populations have remained relatively steady. Although estimates are available for total consumption rates by California sea lions, no analysis has been conducted on the short-term or long-term impact of this consumption on populations of prey. As discussed in the response to another information request of the CCRSG, it does appear that southern sea otters have had an impact on the abundance of some invertebrate populations. The state of California does not have management authority for marine mammals or species listed under the Endangered Species Act. Staff recommends that in designing and evaluating MPAs, the CCRSG take note of the presence of marine mammals in MPA areas and, if appropriate, include the impacts of marine mammals on species of concern in recommended targets for monitoring. Like other monitoring information, this information should be used to monitor the effectiveness of an MPA and to manage it adaptively in the future.

Further information: The following responses emphasize information from central California over information from other regions. Little to no information on historical abundances was available for California sea lions, harbor seals, and southern sea otters, although some early estimates are included for the purposes of comparison with later systematic censuses.

California sea lions: The range of California sea lions extends from the Pacific coast of Baja California to southern British Columbia. These animals breed primarily in the southern part of their range from the Gulf of California to San Miguel Island. Commercial hunting in the 19th and early 20th centuries likely reduced California sea lion populations. In the late 1920s, only 1,000-1,500 California sea lions were counted on the shores of California. Since a general moratorium on hunting marine mammals was imposed with passage of the Marine Mammal Protection Act (MMPA) in 1972, the population has grown substantially to a current estimate of 237,000-244,000 animals. Between 1975 and 2001, the population grew at an average annual rate of 5.4%. California sea lions are plastic specialist predators—that is, they feed on specific species of prey, which change as different species become more abundant seasonally or from year to year. In the case of California sea lions, these species include Pacific hake, northern anchovy, Pacific sardine, spiny dogfish, and squid. In a recent study at Año Nuevo Island, sea lions were found to feed on rockfishes, Pacific whiting, market squid, Pacific sardine, northern anchovy, spiny dogfish shark, and salmonids (Weise and Harvey 2005). Based on this research, Weise and Harvey estimated sea lions in central California consumed 8,406 - 8,447 tons of prey species in 2001-2002, of which 450 tons-1,525 tons were salmonids. In recent years, salmon fishermen have increasingly complained about damage to gear and catches by California sea lions. Between 1997 and 1999, Monterey Bay commercial fishermen suffered estimated losses that ranged from $18,031 to $60,570 for gear and $225,833 to $498,076 in salmon (Weise and Harvey *in press*). For the same period, Weise and Harvey estimated that sea lions fed upon hooked salmon at rates that ranged from 8.5% to 28.6% in the commercial fishery, 2.2% to 18.36% in the CPFV fishery, and 4.0% to 17.5% in the personal skiff fishery. Predation rates were highest in the El Niño year of 1998 when the abundance of other prey was reduced.

Harbor Seals: Harbor seals in the eastern Pacific range from the Pribilof Islands in Alaska to Isla San Martin off Baja. Between the Mexican and Canadian borders, harbor seals have been managed as three separate stocks, of which one is the stock off California. After passage of the MMPA in 1972, harbor seal abundance grew rapidly until 1990, when stocks leveled off. There has been no net population growth in California since 1990 (Caretta *et al.* 2004). In 2002, the population was estimated at 27,863 animals. Harbor seals eat a wide variety of pelagic and benthic prey, including small schooling fishes such as northern anchovy, many species of flatfishes, rockfishes, and cephalopods (Antonelis and Fiscus 1980, Weise and Harvey 2001 and references therein). Diet studies of harbor seals in central California did not find evidence of predation on ocean-swimming salmonids, though they were found to eat small salmonids returning to spawning streams in central and northern California (NMFS 1997; Weise and Harvey 2001).

Southern Sea Otters: Once ranging from northern California to Punta Abreojos in Baja California Sur, with few exceptions, southern sea otters are now found only from Pt Año Nuevo in Santa Cruz County to Purisima Pt in Santa Barbara County (USFWS 1995, 2003). Commercial hunting severely reduced sea otter populations in the 18th and 19th centuries. By 1914, the California population of sea otters may have numbered as few as 50 animals. Between 1983 and 1994, the sea otter population grew at an average annual rate of 5-6%, and reached a maximum observed population size of 2,377 individuals in the spring of 1995. Sea otter numbers have fluctuated since then. Since 1998, the population has increased at a rate of 0.9%, based on the three-year running average. Though recent estimates indicate that the population is growing, recovery is still inhibited by a variety of factors that contribute to otter mortality including: incidental drowning in gill and trammel nets, oil spills, toxic contaminants, other human impacts, and disease (Hanni *et al.* 2003, Miller *et al.* 2004, USFWS 2003). Otters have been shown to be a keystone species, exerting strong top-down control on their prey species (Estes and Palmisano 1974, Estes and Duggins 1995). Their predation on sea urchins has been shown to limit urchin abundance, allowing for the growth of kelp forests and associated species (Estes and Palmisano 1974, Estes and Duggins 1995). Sea otters have a varied diet consisting of benthic invertebrates such as red sea urchins (*Strongylocentrotus franciscanus*), red (*Haliotis rufescens*) and black abalone (*H. cracherodii*), kelp crabs (*Pugettia producta*), clams (*Gari californica*), and cancer crabs (*Cancer spp.*) (Ostfeld 1982). Expansion of sea otter populations, following protection from harvest, resulted in conflicts with commercial and recreational abalone fisheries that had developed when otter numbers were depressed and abalone were abundant (Estes and VanBlaricom 1985). In some locations, predation by otters may have a larger effect on red abalone populations than current human harvest rates (Fanshawe *et al.* 2003). **–End of MLPA Central Coast Study Region Response-**

Response: (Question 7a) Though observational field data shows a recent increase in the number of Humboldt squid (*Dosidicus gigas*) in the California Current ecosystem, it is currently unknown whether these observations represent a permanent range expansion or a temporary intrusion into the north central coast study region at the limit of its range. There is insufficient information on Humboldt squid abundances and feeding habits to accurately predict how increases in their numbers (whether temporary or permanent) can impact local ecosystems. However, as Humboldt squid are predators of commercially-important fish species, as well as being prey of species at higher trophic levels, impacts are conceivable. For the purpose of the MLPA initiative, however, Humboldt squid will probably have negligible direct impacts, as they occur outside of state waters in areas deeper than 200m.

References

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8. **Request a finer gradation of the chart Steve Gaines presented on species home range of 10-100 kilometers. *[Is it possible to disaggregate the 10-100 km category for home ranges into a finer set? (they want to know how many species are protected using a finer resolution on home range size and preferred MPA sizes)]*.** (Mark Carr, Jan Freiwald, Rick Starr)

   This response was approved by the SAT at its November 13, 2007 meeting pending the revisions included below.

   Response: Robust studies of the movements of west coast fish and invertebrates are limited, but a thorough review of available literature conducted by Jan Freiwald, enabled a refinement of the adult movement chart

Adult Movement of West Coast Fish and Invertebrates (after Freiwald, unpublished dissertation)

Move 0-1 km	Move 1-10 km	Move 10-100 km
0-0.5 km	**<3 km**	**>10-20 km**
striped surfperch	black rockfish	Dungeness crab
black surfperch	china rockfish	yellowtail rockfish
kelp greenling	olive rockfish	
rock greenling		**>20 km**

kelp rockfish	**<5 km**	canary rockfish
black-and-yellow rockfish	yelloweye rockfish	bocaccio
monkeyface prickleback*	**5-10 km**	
rock prickleback	lingcod	
	blue rockfish	
<1 km		
giant seabass		
pile surfperch		
vermillion rockfish		
gopher rockfish		
cabezon		
wolf eel		
brown rockfish		
copper rockfish		
quillback rockfish		
starry rockfish*		
grass rockfish*		
treefish*		

* studies of this species had fewer than 10 individuals

9. **The master plan for MPAs science guidelines suggest that marine assemblages may differ depending on the substrate type, even within the broad 'hard bottom' category. Specifically they suggest there may be differences in assemblages in and over granitic and sedimentary substrate on the central coast. In this regard:**
    a. **Does the same hold true for granitic, sedimentary, and Franciscan substrate on the north central coast?**
    b. **If so, does the SAT know of some way to predict where these substrates occur given the Rikk Kvitek data or otherwise?**
    c. **Can the SAT provide more information on what the composition of the assemblages is likely to be in and over these different substrate types? *(so regional stakeholders know what they're trying to protect, if necessary)***

This response was adopted by the SAT at its October 1, 2007 meeting.

Response: (Question 9a) In general granitic rock forms high relief, broad, dome-shaped reefs relative to sedimentary rock, which tends to form narrow linear ridges, while the relief and morphology of Franciscan formations is highly variable and tends toward isolated sea stacks. In the central coast region, studies have shown that substrate relief influences fish assemblages. There is no data in the NCCSR to determine if such species-habitat relationships occur in the north central region, however, it is likely that reef relief influences fish assemblages in the region, as it does elsewhere.

Response: (Question 9b) Interpretation of multibeam imagery of the ocean floor by Dr. Guy Cochrane (U.S. Geological Survey) and Irina Kogan (Gulf of the Farallones National

Marine Sanctuary) in combination with other geological resources indicates that hard substrates in the MLPA North Central Coast Study Region include granitic and sedimentary rocks of the Salinian terrace, sedimentary rocks of the Great Valley Complex, and metasedimentary and metavolcanic rocks of the Franciscan Complex.

- From Pigeon Point (southern boundary of the study region) north to Elephant Rock (just south of Tomales Point) coastal substrate is largely sedimentary rock. Exceptions include:
  - Granite in Montara
  - Franciscan metasedimentary and metavolcanic rocks between Point San Pedro (Pacifica) and in Daly City where the San Andreas fault cuts across the coastline
  - Franciscan rocks (mix of rock types like in the Big Sur coast) between the Golden Gate and eastern Bolinas Lagoon (Wentworth 1997, USGS Open File Report 97-744 Part 5)
- Rock formations from Elephant Rock to Mussel Point and extending offshore to the northwest are granitic.
- From north of Mussel Point to Northwest Cape along the mainland (east of the San Andreas fault) the substrate is metamorphic Franciscan.
- Rock formations from Northwest Cape to Point Arena are sedimentary (Great Valley Complex turbidite sandstone and conglomerate) (Blake et al. 2002, USGS Miscellaneous field studies map MF-2402).

Response: (Question 9c) There are no data in the MLPA North Central Coast Study Region to allow the science advisory team to predict how fish assemblages may vary across the three available substrate types. Based on studies conducted in the MLPA Central Coast Study Region, it is likely that sedimentary formations will support relatively more foliose red algae than benthic invert cover due to the friable/erodable nature of the rock which does not provide a firm substrate for invertebrates. It is also likely that the softer sedimentary substrate will support a greater proportion of burrowing species (eg. Pholad clams).