*The following supplement accompanies the article*

# Ecosystem structure and processes at Kaloko Honokōhau, focusing on the role of herbivores, including the green sea turtle *Chelonia mydas*, in reef resilience

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**SUPPLEMENT:** This supplement provides additional information with regards to species included in each reef fish functional group (Table S1) and detailed descriptions of information/data available for estimating the input parameters of all 26 functional groups included in the Kaloko model (Table S2).

Table S1. Species that were included under each reef fish functional group and were recorded during the 2005 underwater visual census surveys (Beets et al. 2010)

| Functional group | 2005 survey data |
|---|---|
| **Corallivores** | *Arothron meleagris* |
| | *Cantherhines dumerilii* |
| | *Chaetodon multicinctus* |
| | *Chaetodon ornatissimus* |
| | *Chaetodon quadrimaculatus* |
| | *Plectroglyphidodon johnstonianus* |
| **Detritivores** | *Ctenochaetus hawaiiensis* |
| | *Ctenochaetus strigosus* |
| **Herbivores** | *Abudefduf sordidus* |
| | *Acanthurus blochii* |
| | *Acanthurus dussumieri* |
| | *Acanthurus leucopareius* |
| | *Acanthurus nigrofuscus* |
| | *Acanthurus nigroris* |
| | *Acanthurus olivaceus* |
| | *Acanthurus triostegus* |
| | *Calotomus carolinus* |
| | *Canthigaster jactator* |
| | *Cantherhines sandwichiensis* |
| | *Centropyge fisheri* |
| | *Centropyge potteri* |
| | *Chlorurus sordidus* |

| | |
|---|---|
| | *Cirripectes vanderbilti*<br>*Melichthys niger*<br>*Melichthys vidua*<br>*Naso lituratus*<br>*Naso unicornis*<br>*Scarus psittacus*<br>*Scarus rubroviolaceus*<br>*Stegastes fasciolatus*<br>*Zebrasoma flavescens*<br>*Zebrasoma veliferum* |
| **Mobile Invertebrate Feeders (MIF)** | *Bodianus bilunulatus*<br>*Coris gaimard*<br>*Coris venusta*<br>*Diodon hystrix*<br>*Echidna nebulosa*<br>*Forcipiger longirostris*<br>*Gomphosus varius*<br>*Halichoeres ornatissimus*<br>*Lutjanus kasmira*<br>*Malacanthus brevirostris*<br>*Macropharyngodon geoffroy*<br>*Monotaxis grandoculis*<br>*Mulloidichthys flavolineatus*<br>*Paracirrhites arcatus*<br>*Parupeneus bifasciatus*<br>*Parupeneus multifasciatus*<br>*Parupeneus pleurostigma*<br>*Plectroglyphidodon imparipennis*<br>*Pseudojuloides cerasinus*<br>*Pseudocheilinus evanidus*<br>*Pseudocheilinus octotaenia*<br>*Pseudocheilinus tetrataenia*<br>*Rhinecanthus aculeatus*<br>*Rhinecanthus rectangulus*<br>*Sebastapistes coniorta*<br>*Stethojulis balteata*<br>*Sufflamen bursa*<br>*Sufflamen fraenatus*<br>*Thalassoma duperrey*<br>*Thalassoma trilobatum*<br>*Xyrichtys aneitensis* |
| **Piscivores** | *Aphareus furca*<br>*Aulostomus chinensis*<br>*Cephalopholis argus*<br>*Fistularia commersonii*<br>*Gymnothorax flavimarginatus*<br>*Labroides phthirophagus*<br>*Oxycheilinus unifasciatus*<br>*Parupeneus cyclostomus*<br>*Paracirrhites forsteri*<br>*Plagiotremus ewaensis*<br>*Plagiotremus goslinei* |

| | |
|---|---|
| **Sessile Invertebrate Feeders (SIF)** | *Chaetodon auriga*<br>*Chaetodon lineolatus*<br>*Chaetodon lunula*<br>*Forcipiger flavissimus*<br>*Ostracion meleagris*<br>*Zanclus cornutus* |
| **Zooplanktivores (Zoo)** | *Abudefduf abdominalis*<br>*Abudefduf vaigiensis*<br>*Acanthurus thompsoni*<br>*Chromis agilis*<br>*Chromis hanui*<br>*Chaetodon miliaris*<br>*Chromis vanderbilti*<br>*Chromis verater*<br>*Dascyllus albisella*<br>*Heniochus diphreutes*<br>*Hemitaurichthys thompsoni*<br>*Myripristis berndti*<br>*Myripristis kuntee*<br>*Naso hexacanthus*<br>*Xanthichthys auromarginatus* |

Table S2. Input data, sources, and relevant observations by functional group for the Kaloko Honokōhau National Historical Park Ecopath model. Whenever several species were included as part of a trophic guild, overall values were weighted according to individual species' biomass contribution within their respective functional group. For species/groups that only typically occur in a given habitat, their biomass was area-weighted relative to the proportion of each benthic habitat category within Kaloko waters (the latter based on Gibbs et al. 2007). The listed sources indicate studies on which our calculations were based to derive input values for Ecopath. B: biomass; P/B: productivity to biomass ratio; Q/B: consumption to biomass ratio; EE: ecotrophic efficiency; MIF: mobile invertebrate feeders; SIF: sessile invertebrate feeders; CCA: Crustose coralline algae; $turf_{LB}$: Turf algae growing on the nearshore and intertidal lava bench.

| **Functional group** | **Value** | **Source** | **Comments** |
|---|---|---|---|
| *1. Spinner dolphins* | | | |
| B | 2.740 t km$^{-2}$ | Norris et al. (1994) | 960 animals are considered to regularly frequent the western shore of the Big Island. We assumed that only a fraction of this number (100 dolphins) can be considered resident within Kaloko and feed there regularly. Average mass = 68 kg. |
| P/B | 0.151 yr$^{-1}$ | Barlow & Boveng (1991) | We assumed P/B = M and an average longevity of 20 yrs (NMFS 2003, 2005b). |
| Q/B<br>Method 1 | 11.520 yr$^{-1}$<br>15.700 yr$^{-1}$ | Average of 3 methods<br>See comments | Estimate based on a daily ration $R = 0.1(W^{0.8})$, as modified from Innes et al. (1987) in Trites & Heise (1996), where $W$ is body weight in kg and $R$ is the daily ration in kg d$^{-1}$. Hunt et al. (2000) described energy requirements using the equation $E = a\ (W^{0.75})$, where $E$ is the energy requirement per day (kcal d$^{-1}$), $W$ is the mean body weight (kg), and $a$ is a coefficient varying with the group of mammals ($a$ = 320 for otariids, 200 for phocids, 192 for mysticetes, 317 for odontocetes, and 320 for sea otters). |
| Method 2 | 12.200 yr$^{-1}$ | Hunter (2005) | Coefficient estimate was changed from 0.75 to 0.714. |
| Method 3 | 6.660 yr$^{-1}$ | Benoit-Bird (2004) | Based on the assumption that daily maintenance energy needs of a spinner dolphin range between 2430 and 4050 kcal, with an estimate of 3520 kcal for an average adult. |
| Diet | | Norris & Dohl (1980), Norris et al. (1994), Perrin & Gilpatrick (1994), Würsig et al. (1994), Perrin (1998), Benoit-Bird & Au (2003) | Small mesopelagics; bottom dwelling, and small numbers of surface dwelling species; as well as crustaceans. As species is expected to also feed outside of park waters, a substantial proportion of the diet was assumed to be 'imports.' |
| *2. Monk seals* | | | |
| B | 0.179 t km$^{-2}$ | Baker & Johanos (2004), T. Wurth (pers. comm.) | We assumed for only 2, out of the minimum 52 individuals recorded during a 2001 aerial survey in the Main Hawaiian Islands (Baker & Johanos 2004), to be using and feeding in park waters. Although seals regularly haul out in the park, most of them cannot be assumed to utilize Kaloko's waters as foraging habitat (i.e. have the park's coastal resources contribute to their diet). Average mass = 187.5 kg (NMFS 2005a, Protected Species Division 2006). |
| P/B | 0.121 yr$^{-1}$ | Barlow & Boveng (1991) | We assumed P/B = M and a longevity estimate of 25 yr (NMFS 2005a, 2006, 2007). |
| Q/B<br>Method 1<br>Method 2 | 11.510 yr$^{-1}$<br>10.270 yr$^{-1}$<br>12.820 yr$^{-1}$ | See comments | As detailed above for spinner dolphins and 2 estimates of average caloric prey content calculated from data presented by Goodman-Lowe et al. (1999a, b). |

| Functional group | Value | Source | Comments |
|---|---|---|---|
| Diet | | Goodman-Lowe (1998), Longenecker et al. (2006) | Typical prey species include marine eels (Congridae, Muraenidae, and Ophicthidae) and various reef fish such as wrasse (Labridae), squirrelfish and soldierfish (Holocentridae), and triggerfish (Balistidae), followed by cephalopods and crustaceans. As species is expected to also feed outside of park waters, a proportion of the diet was assumed to be 'imports.' |
| *3. Birds* | | | |
| B | 0.0024 t $km^{-2}$ | K. Uyehara (pers. comm.), S. Waddington (pers. comm.) | Model included Hawaiian stilt *Himantopus mexicanus knudseni*, sanderling *Calidris alba*, ruddy turnstone *Arenaria interpres*, wandering tattler *Tringa incana*, Pacific golden plover *Pluvialis fulva*, and black-crowned night heron *Nycticorax nycticorax hoactli*, as these species are known to use the rocky intertidal beach areas for feeding, especially during low tides (Morin 1994). Portion of park available to forage = 0.1 $km^2$ (S. Waddington pers. comm.). Individual species' weight data were extracted from a number of sources (e.g. Reed et al. 1998, Nettleship 2000, Gill et al. 2002, MacWhirter et al. 2002, US FWS 2005). |
| P/B | 0.127 $yr^{-1}$ | Reed et al. (1998), Nettleship (2000), Gill et al. (2002) | Computed from survivorship data. |
| Q/B | 76.515 $yr^{-1}$ | Nilsson & Nilsson (1976) in Wada (1996) | |
| Diet | | See comments | Hawaiian stilts are opportunistic feeders that eat a variety of invertebrates and vertebrates available in shallow water and mudflats, such as polychaete worms, small crabs, aquatic insects, and small fish (http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm). Sanderlings' diet changes markedly between seasons, consisting almost exclusively of insects during the breeding season, and small crabs, isopods, insects, amphipods, polychaetes, and small mollusks in winter (http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm, Perez Hurtado et al. 1997, Tsipoura & Burger 1999, Petracci 2002, Nuka et al. 2005). Pacific golden plovers feed primarily on terrestrial insects, but also forage in the intertidal areas and opportunistically prey on aquatic invertebrates (http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm, Kato et al. 2000). Outside of the breeding season, ruddy turnstones prey on crustaceans, mollusks, polychaetes, and small fish (http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm, Tsipoura & Burger 1999, Nettleship 2000). The diet of wandering tattlers varies with season and in winter tends to consist of invertebrates such as marine worms, aquatic insects, mollusks, and crustaceans, as well as small fish (http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm, Gill et al. 2002). The black-crowned night heron is an opportunistic feeder, whose diet consists mainly of fish, although it will occasionally feed on other items such as earthworms and aquatic and terrestrial insects (Wolford & Boag 1971). It has also been observed to feed on crayfish, mussels, squid, amphibians, lizards, snakes, and plant material (Hothem et al. 2010). As species are expected to also feed outside of park waters, a proportion of their diet was assumed to be 'imports.' |

| Functional group | Value | Source | Comments |
|---|---|---|---|
| *4. Rays* | | | |
| B | 4.233 t $km^{-2}$ | T. Clark (unpubl. data) | Includes the spotted eagle ray *Aetobatus narinari* and the manta ray *Manta birostris* |
| P/B | 0.200 $yr^{-1}$ | Z = M where M = empirical equation from Pauly (1980) | |
| Q/B | 3.100 $yr^{-1}$ | FishBase, Olson & Watters (2003) | |
| Diet | | FishBase, T. Clark (unpubl. data) | Manta rays: zooplankton; spotted eagle rays: mostly benthic invertebrates. As species are expected to also feed also outside of park waters, a proportion of their diet was assumed to be 'imports.' |
| *5. Sharks and jacks* | | | |
| B | 0.070 t $km^{-2}$ | Parrish et al. (1990), Friedlander & DeMartini (2002) | Includes the tiger shark *Galeocerdo cuvier* (see www.state.hi.us/dlnr/chair/pio/HtmlNR/01-46.htm, http://starbulletin.com/2005/07/01/news/index5.html, Meyer et al. 2009) and whitetip reef shark *Triaenodon obesus*, as well as other top predators such as bluefin trevally *Caranx melampygus*, bigeye trevally *C. sexfasciatus*, mackerel scad *Decapterus macarellus*, golden trevally *Gnathanodon speciosus*, doublespotted queenfish *Scomberoides lysan*, bigeye scad *Selar crumenophthalmus*, and greater amberjack *Seriola dumerili* (www.nps.gov/kaho/). |
| P/B | 1.058 $yr^{-1}$ | Z = F + M where M = empirical equation from Pauly (1980); F based on Friedlander & Parrish (1997) | |
| Q/B | 5.100 $yr^{-1}$ | FishBase | |
| Diet | | FishBase, Lowe et al. (1996) | Predates on all groups with the exception of coral and algal groups and phytoplankton. As species are expected to also feed also outside of park waters, a proportion of their diet was assumed to be 'imports.' |
| *6. Hawksbill sea turtles* | | | |
| B | 0.054 t $km^{-2}$ | S. Beavers (unpubl. data) | Hawksbill turtles are seen at specific sites within Kaloko on a regular basis (S. Beavers unpubl. data). Although a number of them just travel through, hawksbill turtles have been filmed feeding and attempting to mate in park waters. We assumed that 3 hawksbill turtles are 'resident' at Kaloko. Each turtle was assumed to weigh about 45 kg. |
| P/B | 0.109 $yr^{-1}$ | Crouse (1999) | |
| Q/B | 3.500 $yr^{-1}$ | Best estimate | |
| Diet | | See comments | Hawksbill turtles primarily feed on sponges and benthic invertebrates (Bjorndal 1997). In Hawai'i, sponges are not abundant, and limited information gained through necropsies and visual observations indicates that hawksbill turtles appear to feed on sea cucumbers (S. Beavers unpubl. data), fireworms (C. King pers. comm.), and red algae (G. Balazs unpubl. data). As species is expected to also feed outside of park waters, a small proportion of the diet was assumed to be 'imports.' |

| Functional group | Value | Source | Comments |
|---|---|---|---|
| *7. Green sea turtles* | | | |
| B | 1.591 t $km^{-2}$ | G. Balazs (unpubl. data), S. Beavers & NPS (unpubl. data) | Of the 196 green turtles associated with Kaloko, 143-161 of them show high site fidelity and can thus be considered Kaloko 'residents.' Average weight of green turtles captured in 2005 was 27.6 kg (NOAA NMFS Marine Turtle Research Program & NPS unpubl. data). |
| P/B | 0.109 $yr^{-1}$ | Bjorndal et al. (2003) | |
| Q/B | 6.764 $yr^{-1}$ | Brand et al. (1999) | Based on an average body weight intake of 1.8% $d^{-1}$ (recalculated from Brand et al. 1999, using the length-weight relationship published by Arthur et al. 2006, as the original study was conducted in Australia; note, however, that both studies were conducted in seagrass environments). |
| Diet | | G. Balazs (unpubl. data), S. Beavers & NPS (unpubl. data) | Turf algae and macroalgae, with $turf_{LB}$ constituting the primary dietary component of green turtles within park waters based on green turtles seen to focus foraging activities on the lava bench. |
| *8 - 14. Reef fish* | | | |
| B<br>Piscivores<br>Herbivores<br>Corallivores<br>Detritvores<br>MIF<br>SIF<br>Zooplanktivores | <br>1.730 t $km^{-2}$<br>20.340 t $km^{-2}$<br>0.540 t $km^{-2}$<br>2.260 t $km^{-2}$<br>9.760 t $km^{-2}$<br>0.540 t $km^{-2}$<br>3.050 t $km^{-2}$ | Beets et al. (2010) | Reef fish biomass values were based on data from Beets et al. (2010) and extrapolated to the entire park using the proportion that individual benthic habitat categories cover within park waters following Gibbs et al. (2007). Fish species were grouped according to the same functional groups used by Beets et al. (2010): corallivores, detritivores, herbivores, mobile invertebrate feeders (MIF), piscivores, sessile invertebrate feeders (SIF), and zooplanktivores (Zoo). See Table S1 for a complete species list. |
| P/B<br>Piscivores<br>Herbivores<br>Corallivores<br>Detritvores<br>MIF<br>SIF<br>Zooplanktivores | <br>0.620 $yr^{-1}$<br>1.400 $yr^{-1}$<br>2.100 $yr^{-1}$<br>1.900 $yr^{-1}$<br>0.950 $yr^{-1}$<br>1.700 $yr^{-1}$<br>1.450 $yr^{-1}$ | For all reef fish functional groups, $Z = F + M$ where M = empirical equation from Pauly (1980); F based on Friedlander & Parrish (1997), where applicable | |
| Q/B<br>Piscivores<br>Herbivores<br>Corallivores<br>Detritvores<br>MIF<br>SIF<br>Zooplanktivores | <br>6.120 $yr^{-1}$<br>27.150 $yr^{-1}$<br>12.920 $yr^{-1}$<br>32.270 $yr^{-1}$<br>8.110 $yr^{-1}$<br>9.580 $yr^{-1}$<br>13.380 $yr^{-1}$ | FishBase | |

| **Functional group** | **Value** | **Source** | **Comments** |
| --- | --- | --- | --- |
| Diet | | e.g. Hobson (1974), FishBase, Bruggemann et al. (1994 ), Guiasu & Winterbottom (1998), Choat et al. (2002), Marnane & Bellwood (2002), DeFelice & Parrish (2003), Paddack et al. (2006), Dierking et al. (2009) | See diet table in manuscript for diet composition of individual groups. |
| *15. Urchins* | | | |
| B | 280 t km$^{-2}$ | Dotan (1990), McClanahan & Kurtis (1991), Rahman et al. (2001, 2004), Muthiga & Jaccarini (2005), Marrack et al. (2009), Weijerman et al. (2009) | The most frequently encountered urchins during surveys were *Echinometra mathaei*, *Echinothrix* spp. (i.e. *E. diadema* and *E.calamaris*), *Heterocentrotus mammilatus*, and *Tripneustes gratilla.* Test sizes for *Echinothrix* spp., *T. gratilla, E. mathaei,* and *H. mammilatus* were recorded on the reef by local researchers (M. Weijerman pers. comm., H. Jessop pers. comm.) and converted to biomass based on published test size–weight relationships (Dotan 1990, McClanahan & Kurtis 1991, Rahman et al. 2001, 2004, Muthiga & Jaccarini 2005). We assumed that urchins occur chiefly on colonized substrate with at least 10% coral cover (M. Weijerman pers. comm.) and in reduced numbers at depth (F. Parrish pers. comm.). |
| P/B | 0.484 yr$^{-1}$ | Brey (2001) | |
| Q/B | 8.547 yr$^{-1}$ | See comments | Q/B rates for *Tripneustes gratilla* were derived based on feeding experiments conducted: (1) on *T. gratilla* and using averages for 3 species of algae employed in trials (14.720 yr$^{-1}$; M. Deagle pers. comm.); and (2) on *T. gratilla* and *Echinothrix* spp. using *Gracilaria* only (13.900 yr$^{-1}$; H. Jessop pers. comm.). Q/B for *Echinometra mathaei* was set at 4.440 yr$^{-1}$ based on data for Kenya from Carreiro-Silva & McClanahan (2001) and McClanahan & Kurtis (1991). For *Echinothrix* spp., the Q/B was set at 7.860 yr$^{-1}$, the average between values reported by Carreiro-Silva & McClanahan (2001) and those obtained from feeding trials by H. Jessop (pers. comm.). *Heterocentrotus mammilatus* was assigned the same Q/B rate as *Echinothrix* spp. |
| Diet | | See comments | Observations at K□ne‘ohe Bay, Oahu, Hawai’i, by Stimson et al. (2007) showed that diet composition of *Tripneustes gratilla* typically reflects the algal distribution found on the reef, with individuals observed feeding on a variety of macroscopic algae, coralline algae, endolithic algae, and turfs. In Hawai’i, *Echinothrix calamaris* has been observed feeding on coralline algae, filamentous algae, brown algae (Castro 1971 as cited in de Ridder & Lawrence 1982). *E. diadema* is known to forage on algae and encrusting organisms (Mortensen 1940 as cited in de Ridder & Lawrence 1982). *Heterocentrotus mammilatus* has been seen to gnaw algae from bare substrate or the coral surface (Mortensen 1943 and Dart 1972 as cited in de Ridder & Lawrence 1982) and consume crustose coralline algae (CCA; Regis & Thomassin 1983). *Echinometra mathaei* is a generalized herbivore, feeding on a variety of macrophytes (McClanahan & Muthiga 2001), and preferentially on turf growing on the surface of dead coral or pavement, which explains why calcium carbonate sediments are usually the largest fraction of the gut content of *Echinometra* (Odum & Odum 1955, Black et al. 1984, McClanahan & Kurtis 1991, Mills et al. 2000). |

| Functional group | Value | Source | Comments |
|---|---|---|---|
| *16. Crown-of-thorns* | | | |
| B | 0.117 t $km^{-2}$ | Marrack et al. (2009), Weijerman et al. (2009) | We assumed that (1) an individual weighs on average 466 g (Branham et al. 1971) and (2) *Acanthaster planci* only occurs in areas with >50% coral cover. |
| P/B | 0.411 $yr^{-1}$ | Brey (2001) | Maximum age was set to 8 yrs (Zann et al. 1990) and maximum weight was derived from Branham et al. (1971). |
| Q/B | 9 $yr^{-1}$ | Moran (1990), Keesing & Lucas (1992), Reyes-Bonilla & Calderon-Aguilera (1999), Scandol (1999) | Estimates ranged between 5.969 and 12.065 $yr^{-1}$. |
| Diet | | Birkeland & Lucas (1990) | Hermatypic scleractinian corals. |
| *17. Benthic invertebrates* | | | |
| B | Estimated by Ecopath (EE = 0.95) | Parrish et al. (1990) | Only qualitative data available. Species included white-spotted cucumber *Actinopyga mauritiana*, snapping shrimp *Alpheus crassimanus*, helmet urchin *Colobocentrotus atratus*, lightfoot crab *Grapsus tenuicrustatus*, sea cucumbers (*Holothuria* sp.), black purse shell *Isognomon californicum*, black nerite *Nerita picea* (freshwater, brackish), banded coral shrimp *Stenopus hispidus*, and the cushion star *Culcita novaeguineae* (mainly based on http://www.botany.hawaii.edu/basch/uhnpscesu/htms/kahoinvr/index.htm). Although not surveyed, it seems reasonable to assume that polychaetes would constitute a significant proportion of the benthic invertebrate functional group. |
| P/B | 2.910 $yr^{-1}$ | Tudman (2001) | |
| Q/B | 15.250 $yr^{-1}$ | Tudman (2001) | |
| Diet | | Brey (2001) | Zooplankton, phytoplankton, and detritus. A small portion of their diet was assumed to be 'imports' to reflect the likely contribution of zooplankton from outside park waters. |
| *18. Corals* | | | |
| B | 130 t $km^{-2}$ | Gibbs et al. (2007), Marrack et al. (2009),Weijerman et al. (2009) | We assumed that 0.5 $km^2$ of Kaloko was covered with 100% coral and used estimations of Odum & Odum (1955) for biomass of heterotrophic tissue (polyps) and zooxanthellae (average of 0.021 and 0.0038 g dry weight $cm^{-2}$ of coral skeleton). Values published by Atkinson & Grigg (1984) were used for dry-to-wet weight conversions. |
| P/B | 0.140 $yr^{-1}$ | Babcock (1991), Chadwick-Furman et al. (2000) | Based on 3 species of corals with relatively similar life characteristics to *Porites* spp., the dominant genus at Kaloko. |
| Q/B | 2.100 $yr^{-1}$ | Johannes & Tepley (1974), Palardy et al. (2006) | We assumed here that autotrophically acquired carbon contributes ~60% of animal respiration (Johannes & Tepley 1974). We reduced the original estimate (5.840 $yr^{-1}$) based on the proportion of energy the species derives from heterotrophic feeding and evidence of patchy distribution of zooplankton over reefs (Palardy et al. 2006). |
| Diet | | Rosenfeld et al. (1999), Ribes et al. (2003a), Palardy et al. (2008) | Zooplankton, followed by detritus and phytoplankton. A small portion of their diet was assumed to be 'imports' to reflect the likely contribution of zooplankton from outside park waters. |

| Functional group | Value | Source | Comments |
|---|---|---|---|
| *19. Octocorals* | | | |
| B | 2.900 t $km^{-2}$ | Marrack et al. (2009), Beets et al. (2010) | *Sarcothelia edmonsoni.* |
| P/B | 0.200 $yr^{-1}$ | Goffredo & Lasker (2008) | Despite benefiting from the photosynthetic products of its endosymbionts, *Sarcothelia edmonsoni* may derive a significant proportion of its carbon through suspension feeding of particulate and dissolved organic matter from the surrounding environment (Fabricius et al. 1995, 1998). We therefore assumed that heterotrophically acquired carbon contributes about 80% of animal respiration. |
| Q/B | 4.630 $yr^{-1}$ | Sorokin (1991), Ribes et al. (2003b) | Reduced from 9.250 $yr^{-1}$ based on the proportion of energy the species derives from heterotrophic feeding and evidence of patchy distribution of zooplankton over reefs (Palardy et al. 2006). |
| | | | |
| Diet | | Coma et al. (1994), Ribes et al. (1998, 1999, 2003b), Orejas et al. (2003), Rossi et al. (2004), Tsounis et al. (2006), Picciano & Ferrier-Pages (2007) | Zooplankton, phytoplankton, and detritus. A small portion of their diet was assumed to be 'imports' to reflect the likely contribution of zooplankton from outside park waters. |
| *20. Macroalgae* | | | |
| B | 22.691 t $km^{-2}$ | Smith et al. (2001), Beets et al. (2006), T. Sauvage (unpubl. data), Marrack et al. (2009), Weijerman et al. (2009) | Estimates based on cover (0.62%; Marrack et al. 2009, Weijerman et al. 2009, Beets et al. 2010), data published by Smith et al. (2001), and those kindly provided by T. Sauvage from experiments conducted in 2003 and 2004 in Waikiki (unpubl. data). |
| P/B | 9.824 $yr^{-1}$ | Payri (2000) | |
| *21. CCA* | | | |
| B | 37.818 t $km^{-2}$ | Smith et al. (2001), Marrack et al. (2009), Weijerman et al. (2009), Beets et al. (2010), T. Sauvage (unpubl. data), | Estimates based on cover (10.46%; Marrack et al. 2009, Weijerman et al. 2009, Beets et al. 2010) and data published by Smith et al. (2001). |
| P/B | 1.777 $yr^{-1}$ | Payri (2000) | Conversion rates between gC, dry mass (DM), and wet weight (WW) were taken from Atkinson & Grigg (1984). |
| *22. Turf algae* | | | |
| B | 128.780 t $km^{-2}$ | Smith et al. (2001), Beets et al. (2006), T. Sauvage (unpubl. data), Marrack et al. (2009), Weijerman et al. (2009) | 'Turf algae' includes 20 different algal genera (McDermid et al. 2007). Estimates based on cover (33.13%; Marrack et al. 2009, Weijerman et al. 2009) and data published by Smith et al. (2001), and those kindly provided by T. Sauvage from experiments conducted in 2003 and 2004 in Waikiki (unpubl. data). |
| P/B | 19 $yr^{-1}$ | Payri (2000) | Conversion rates between gC, dry mass (DM), and wet weight (WW) were taken from Atkinson & Grigg (1984). |

| Functional group | Value | Source | Comments |
|---|---|---|---|
| *23. Turf$_{LB}$* | | | |
| B | 3.065 t km$^{-2}$ | | Turf algae restricted to the shallow lava bench and intertidal area in Honokōhau Bay, (0.026 km$^2$; based on Gibbs et al. 2007). Assumed 65% cover (T. Sauvage pers. comm.). |
| P/B | 25 yr$^{-1}$ | Klumpp & McKinnon (1992), Arias-González (1994), Payri (2000), Bozec et al. (2004) | Higher than turf algae on the rest of the reef as shallow dense turf registers higher productivity rates than deeper reef turf (T. Sauvage pers. comm.). Conversion rates between gC, dry mass (DM), and wet weight (WW) were taken from Atkinson & Grigg (1984). |
| *24. Zooplankton* | | | |
| B | 1.240 t km$^{-2}$ | Bienfang (1980, 1983) | Zooplankton biomass (g WW) for the entire park area was derived by integrating the average tow biomass (Bienfang 1980, 1983) over an average water column depth weighted by the surface area of each of 12 habitats, as listed in Gibbs et al. (2007). |
| P/B | 219 yr$^{-1}$ | Calbet et al. (2000) | Zooplankton samples were dominated by copepods (see Table 2 in Hoover & Gold 2005). |
| Q/B | 949 yr$^{-1}$ | Calbet et al. (2000), Bienfang (1980, 1983) | Zooplankton samples were dominated by copepods (see Table 2 in Hoover & Gold 2005). |
| Diet | | Bienfang (1980, 1983), Roman et al. (2001) | We assumed that zooplankton species at Kaloko are mostly herbivorous but included a fraction of their diet as detritus and zooplankton. We assumed that a small portion of zooplankton diet comes from outside park waters (i.e. included as 'imports'). |
| *25. Phytoplankton* | | | |
| B | 3.295 t km$^{-2}$ | Bienfang & Johnson (1980) | We used the average value of measurements made in 1980 at 1.5 and 5 m depth at the oceanic station 150 m outside of Honokōhau Harbor. Phytoplankton biomass for the entire park was calculated using the same protocol as for zooplankton. In line with values observed in 1994 to 1996 and 2000 at coastal sites in the park 100 to 200 m offshore of Kaloko and 'Aimakapa ponds (Brock & Kam 1997, Marine Consultants 2000 as cited by Hoover & Gold 2005). |
| P/B | 325.458 yr$^{-1}$ | Bienfang & Johnson (1980) | Used average C:Chlorophyll ratio of 90 based on values in Taylor et al. (1997), Charpy & Blanchot (1998), Yahel et al. (1998), and Barbosa et al. (2001). |
| *26. Detritus* | | | |
| B | 100 t km$^{-2}$ | | Default value in Ecopath. |

LITERATURE CITED

Arias-González JE (1994) Trophic balance of a reef ecosystem (Tiahura-Moorea-French Polynesia). C R Acad Sci Serie III Sci Vie 317:1143–1150

➤ Arthur KE, Limpus CJ, Roelfsema CM, Udy JW, Shaw GR (2006) A bloom of *Lyngbya majuscula* in Shoalwater Bay, Queensland, Australia: an important feeding ground for the green turtle (*Chelonia mydas*). Harmful Algae 5:251–265

➤ Atkinson MJ, Grigg RW (1984) Model of a coral reef ecosystem. Coral Reefs 3:13–22

➤ Babcock RC (1991) Comparative demography of 3 species of scleractinian corals using age-dependent and size-dependent classifications. Ecol Monogr 61:225–244

➤ Baker JD, Johanos TC (2004) Abundance of the Hawaiian monk seal in the main Hawaiian Islands. Biol Conserv 116:103–110

➤ Barbosa AB, Galvao HM, Mendes PA, Alvarez-Salgado XA, Figueiras FG, Joint I (2001) Short-term variability of heterotrophic bacterioplankton during upwelling off the NW Iberian margin. Prog Oceanogr 51:339–359

➤ Barlow J, Boveng P (1991) Modeling age-specific mortality for marine mammal populations. Mar Mamm Sci 7:50–65

Beets J, Brown E, Friedlander A (2010) Inventory of marine vertebrate species and fish-habitat utilization patterns in coastal waters off four National Parks in Hawai'i. Pacific Cooperative Studies Unit Technical Report 168. University of Hawai`i at Mānoa, Department of Botany, Honolulu, HI

➤ Benoit-Bird KJ (2004) Prey caloric value and predator energy needs: foraging predictions for wild spinner dolphins. Mar Biol 145:435–444

Benoit-Bird KJ, Au WWL (2003) Prey dynamics affect foraging by a pelagic predator (*Stenella longirostris*) over a range of spatial and temporal scales. Behav Ecol Sociobiol 53:364–373

Bienfang P (1980) Water quality characteristics of Honokōhau harbor: a subtopical embayment affected by groundwater intrusion. Pac Sci 34:279–291

Bienfang PK (1983) The status of water quality, water circulation and plankton populations in Honokōhau small boat harbor, 1982. A decade of ecological studies following construction of Honokōhau small boat harbor, Kona, Hawaii. US Army Corps of Engineers, Honolulu, HI

Bienfang P, Johnson W (1980) Planktonic properties of Honokōhau harbor: a nutrient enriched subtropical embayment. Pac Sci 34:293–300

Birkeland C, Lucas J (1990) *Acanthaster planci*: major management problem of coral reefs. CRC Press, Boca Raton, FL

Bjorndal KA (1997) Foraging ecology and nutrition of sea turtles. In: Lutz PL, Musick JA (eds) The biology of sea turtles. CRC Press, New York, NY, p 199–231

➤ Bjorndal K, Bolten A, Chaloupka M (2003) Survival probability estimates for immature green turtles *Chelonia mydas* in the Bahamas. Mar Ecol Prog Ser 252:273–281

➤ Black R, Codd C, Hebbert D, Vink S, Burt J (1984) The functional significance of the relative size of Aristotle's lantern in the sea urchin *Echinometra mathaei* (de Blanville). J Exp Mar Biol Ecol 77:81–97

➤ Bozec YM, Gascuel D, Kulbicki M (2004) Trophic model of lagoonal communities in a large open atoll (Uvea, Loyalty islands, New Caledonia). Aquat Living Resour 17:151–162

➤ Brand SJ, Lanyon JM, Limpus CJ (1999) Digesta composition and retention times in wild immature green turtles, *Chelonia mydas*: a preliminary investigation. Mar Freshw Res 50:145–147

➤ Branham JM, Reed SA, Bailey JH, Caperon J (1971) Coral-eating sea stars *Acanthaster planci* in Hawaii. Science 172:1155–1157

Brey T (2001) Population dynamics in benthic invertebrates. A virtual handbook. Version 01.2. Available at www.thomas-brey.de/science/virtualhandbook

Brock RE, Kam AKH (1997) Biological and water quality characteristics of anchialine resources in Kaloko-Honokōhau National Historical Park. University of Hawai'i at Mānoa, Honolulu, HI

➤ Bruggemann JH, Vanoppen MJH, Breeman AM (1994) Foraging by the stoplight parrotfish *Sparisoma viride*. I. Food selection in different socially determined habitats. Mar Ecol Prog Ser 106:41–55

➤ Calbet A, Landry MR, Scheinberg RD (2000) Copepod grazing in a subtropical bay: species-specific responses to a midsummer increase in nanoplankton standing stock. Mar Ecol Prog Ser 193:75–84

➤ Carreiro-Silva M, McClanahan TR (2001) Echinoid bioerosion and herbivory on Kenyan coral reefs: the role of protection from fishing. J Exp Mar Biol Ecol 262:133–153

➤ Chadwick-Furman NE, Goffredo S, Loya Y (2000) Growth and population dynamic model of the reef coral *Fungia granulosa* Klunzinger, 1879 at Eilat, northern Red Sea. J Exp Mar Biol Ecol 249:199–218

➤ Charpy L, Blanchot J (1998) Photosynthetic picoplankton in French Polynesian atoll lagoons: estimation of taxa contribution to biomass and production by flow cytometry. Mar Ecol Prog Ser 162:57–70

➤ Choat JH, Clements KD, Robbins WD (2002) The trophic status of herbivorous fishes on coral reefs. I. Dietary analyses. Mar Biol 140:613-623

➤ Coma R, Gili JM, Zabala M, Riera T (1994) Feeding and prey capture cycles in the aposymbiontic gorgonian *Paramuricea clavata*. Mar Ecol Prog Ser 115:257–270

Crouse D (1999) Population modelling and implications for Caribbean hawksbill sea turtle management. Chelonian Conserv Biol 3:185–188

DeFelice RC, Parrish JD (2003) Importance of benthic prey for fishes in coral reef-associated sediments. Pac Sci 57:359-384

de Ridder C, Lawrence JM (1982) Food and feeding mechanisms: Echinoidea. In: Jangoux M, Lawrence JM (eds) Echinoderm nutrition. A. A. Balkema, Rotterdam, p 57–116

Dierking J, Williams ID, Walsh WJ (2009) Diet composition and prey selection of the introduced grouper species peacock hind (*Cephalopholis argus*) in Hawaii. Fish Bull 107:464-476

➤ Dotan A (1990) Population structure of the echinoid *Heterocentrotus mammillatus* (L) along the littoral zone of southeastern Sinai. Coral Reefs 9:75–80

➤ Fabricius KE, Genin A, Benayahu Y (1995) Flow-dependent herbivory and growth in zooxanthellae-free soft corals. Limnol Oceanogr 40:1290–1301

➤ Fabricius K, Yahel G, Genin A (1998) In situ depletion of phytoplankton by an azooxanthellate soft coral. Limnol Oceanogr 43:354–356

➤ Friedlander AM, DeMartini EE (2002) Contrasts in density, size, and biomass of reef fishes between the northwestern and the Main Hawaiian Islands: the effects of fishing down apex predators. Mar Ecol Prog Ser 230:253–264

➤ Friedlander AM, Parrish JD (1997) Fisheries harvest and standing stock in a Hawaiian bay. Fish Res 32:33–50

Gibbs AE, Cochran SA, Logan JB, Grossman EE (2007) Benthic habitats and offshore geological resources of Kaloko-Honokōhau National Historical Park, Hawai'i. Scientific investigations report 2006-5256. US Geological Survey, Santa Cruz, CA (http://pubs.usgs.gov/sir/2006/5256)

Gill RE, McCaffery BJ, Tomkovich PS (2002) Wandering tattler (*Tringa incana*). In: Poole A (ed) The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/642

Goffredo S, Lasker HR (2008) An adaptive management approach to an octocoral fishery based on the Beverton-Holt model. Coral Reefs 27:751–761

➤ Goodman-Lowe GD (1998) Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the Northwestern Hawaiian Islands during 1991 to 1994. Mar Biol 132:535–546

➤ Goodman-Lowe GD, Carpenter JR, Atkinson S (1999a) Assimilation efficiency of prey in the Hawaiian monk seal (*Monachus schauinslandi*). Can J Zool 77:653–660

➤ Goodman-Lowe GD, Carpenter JR, Atkinson S, Ako H (1999b) Nutrient, fatty acid, amino acid and mineral analysis of natural prey of the Hawaiian monk seal, *Monachus schauinslandi*. Comp Biochem Physiol A Mol Integr Physiol 123:137–146

Guiasu RC, Winterbottom R (1998) Yellow juvenile color pattern, diet switching and the phylogeny of the surgeonfish genus Zebrasoma (Percomorpha, Acanthuridae). Bull Mar Sci 63:277–294

Hobson ES (1974) Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. Fish Bull 72:915–1031

Hoover D, Gold C (2005) Assessment of coastal water resources and watershed conditions in Kaloko-Honokōhau National Historical Park. Hawai'i Tech Rep NPS/NRWRD/NRTR- 2005/344. US Department of the Interior, National Park Service, Water Resource Division. Department of Oceanography, University of Hawai'i at Mānoa, Honolulu, HI

Hothem, RL, Brianne EB, Davis, WE (2010) Black-crowned Night-Heron (*Nycticorax nycticorax*). In: Poole, A (ed) The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/074

Hunt GLJ, Kato H, McKinnel SM (2000) Predation by marine birds and mammals in the subarctic Pacific Ocean. PICES Sci Rep 14. North Pacific Marine Science Organisation, Sidney, BC

Hunter AMJ (2005) A multiple regression model for predicting the energy requirements of marine mammals. MSc thesis, University of British Columbia, Vancouver, BC

➤ Innes S, Lavigne DM, Earle WM, Kovacs KM (1987) Feeding rates of seals and whales. J Anim Ecol 56:115–130

Johannes RE, Tepley L (1974) Examination of feeding of the reef coral *Porites lobata* in situ using time lapse photography. Proc 2nd Int Coral Reef Symp:127–131

➤ Kato K, Omori K, Yoneda M (2000) Feeding ecology of the Pacific golden plover (*Pluvialis fulva*) in the Sg. Labu river on the west coast of the Malay Peninsula. Hydrobiologia 437:221–233

➤ Keesing JK, Lucas JS (1992) Field measurement of feeding and movement rates of the crown-of-thorns starfish *Acanthaster planci* (L). J Exp Mar Biol Ecol 156:89–104

➤ Klumpp DW, McKinnon AD (1992) Community structure, biomass and productivity of epilithic algal communities on the Great Barrier Reef: dynamics at different spatial scales. Mar Ecol Prog Ser 86:77–89

Longenecker K, Dollar R, Cahoon M (2006) Increasing taxonomic resolution in dietary analysis of the Hawaiian monk seal. Atoll Res Bull 543:103–113

➤ Lowe CG, Wetherbee BM, Crow GL, Tester AL (1996) Ontogenetic dietary shifts and feeding behavior of the tiger shark, *Galeocerdo cuvier*, in Hawaiian waters. Environ Biol Fishes 47:203–211

MacWhirter B, Austin-Smith PJ, Kroodsma D (2002) Sanderling (*Calidris alba*). In: Poole A (ed) The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/653

Marrack L, Beavers S, Weijerman M (2009) Baseline assessment of the coral reef habitat adjacent to the shores of Kohanaiki development in Kaloko-Honokōhau National Historical Park. Cooperative Ecosystem Studies Unit, University of Hawai'i at Hilo, Hilo, HI

➤ McClanahan TR, Kurtis JD (1991) Population regulation of the rock-boring sea-urchin *Echinometra mathaei* (Deblainville). J Exp Mar Biol Ecol 147:121–146

McClanahan TR, Muthiga NA (2001) The ecology of Echinometra. In: Edible Sea Urchins: Biology and Ecology. Development in Aquaculture and Fisheries 32. Elsevier, Amsterdam, The Netherlands, p 225-243

McDermid KJ, Stuercke B, Balazs GH (2007) Nutritional composition of marine plants in the diet of the green sea turtle (*Chelonia mydas*) in the Hawaiian Islands. Bull Mar Sci 81:55-71

➤ Meyer CG, Clark TB, Papastamatiou YP, Whitney NM, Holland KN (2009) Long-term movement patterns of tiger sharks *Galeocerdo cuvier* in Hawaii. Mar Ecol Prog Ser 381:223–235

➤ Mills SC, Peyrot-Clausade M, Fontaine MF (2000) Ingestion and transformation of algal turf by *Echinometra mathaei* on Tiahura fringing reef (French Polynesia). J Exp Mar Biol Ecol 254:71–84

➤ Moran PJ (1990) *Acanthaster planci* (L.): biographical data. Coral Reefs 9:95–96

Morin MP (1994) Birds of Kaloko Honokōhau National Historical Park. Tech Rep104. National Biological Service, Hawaii National Park Field Station, HI

➤ Muthiga NA, Jaccarini V (2005) Effects of seasonality and population density on the reproduction of the Indo-Pacific echinoid *Echinometra mathaei* in Kenyan coral reef lagoons. Mar Biol 146:445–453

Nettleship DN (2000) Ruddy turnstone (*Arenaria interpres*). In: Poole A (ed) The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/537

NMFS (2003) Spinner dolphin (*Stenella longisrostris*): Hawaiian stock. Stock Assessment Report. Revised 2003. National Marine Fisheries Service, Silver Spring, MD. http://www.nmfs.noaa.gov/pr/sars/species.htm

NMFS (2005a) Hawaiian monk seal (*Monachus schauinslandi*). Stock Assessment Report. Revised 2005. National Marine Fisheries Service, Silver Spring, MD. http://www.nmfs.noaa.gov/pr/sars/species.htm

NMFS (2005b) Spinner dolphin (*Stenella longisrostris*): Hawaiian stock. Stock Assessment Report. Revised 2005. National Marine Fisheries Service, Silver Spring, MD. http://www.nmfs.noaa.gov/pr/sars/species.htm

NMFS (2006) Hawaiian monk seal (*Monachus schauinslandi*). Stock Assessment Report. Revised 2006. National Marine Fisheries Service, Silver Spring, MD. http://www.nmfs.noaa.gov/pr/sars/species.htm

NMFS (2007) Hawaiian monk seal (*Monachus schauinslandi*) 5-year review: summary and evaluation National Marine Fisheries Service, Pacific Islands Regional Office, Honolulu, HI

Norris KS, Würsig B, Wells RS, Würsig M (1994) The Hawaiian Spinner Dolphin. University of California Press, Berkeley, CA

Norris KS, Dohl TP (1980) Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. Fish Bull 77:821–849

➤ Nuka T, Norman CP, Kuwabara K, Myiyazaki T (2005) Feeding behavior and effect of prey availability on sanderling *Calidris alba* distribution on Kujukuri Beach. Ornithol Sci 4:139–146

Odum HT, Odum EP (1955) Trophic structure and productivity of a windward coral reef community of Eniwetok atoll. Ecol Monogr 25:291–320

Olson RJ, Watters GM (2003) A model of the pelagic ecosystem in the eastern tropical Pacific ocean. Inter-American Tropical Tuna Commission, La Jolla, CA

Orejas C, Gili JM, Arntz W (2003) Role of small-plankton communities in the diet of two Antarctic octocorals (*Primnoisis antarctica* and *Primnoella* sp.). Mar Ecol Prog Ser 250:105–116

➤ Paddack MJ, Cowen RK, Sponaugle S (2006) Grazing pressure of herbivorous coral reef fishes on low coral cover reefs. Coral Reefs 25:461–472

➤ Palardy JE, Grottoli AG, Matthews KA (2006) Effect of naturally changing zooplankton concentrations on feeding rates of two coral species in the Eastern Pacific. J Exp Mar Biol Ecol 331:99–107

➤ Palardy JE, Rodrigues LJ, Grottoli AG (2008) The importance of zooplankton to the daily metabolic carbon requirements of healthy and bleached corals at two depths. J Exp Mar Biol Ecol 367:180–188

Parrish J, Smith G, Norris J (1990) Resources of the marine waters of Kaloko-Honokōhau National Historical Park. Tech Rep 74. Cooperative National Park Resources Study Unit, Department of Botany, University of Hawaii, Honolulu, HI

Pauly D (1980) On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J Cons Int Explor Mer 39:175–192

Payri C (2000) Production primaire et calcification des algues benthiques en milieu corallien. Oceanis 26:427–463

➤ Perez Hurtado A, Goss Custard JD, Garcia F (1997) The diet of wintering waders in Cadiz Bay, southwest Spain. Bird Study 44:45–52

➤ Perrin WF (1998) *Stenella longirostris*. Mamm Species 599:1–7

Perrin WF, Gilpatrick JJ (1994) Spinner dolphin - *Stenella longirostris* (Gray, 1828). In: Ridgway SH, Harrison SR (eds) Handbook of marine mammals, Vol 5: the first book of dolphins. Academic Press, London, p 99–128

➤ Petracci PF (2002) Diet of sanderling in Buenos Aires Province, Argentina. Waterbirds 25:366–370

➤ Picciano M, Ferrier-Pages C (2007) Ingestion of pico- and nanoplankton by the Mediterranean red coral *Corallium rubrum*. Mar Biol 150:773–782

Protected Species Division, Pacific Islands Fisheries Science Center, NMFS (National Marine Fisheries Service) (2006) Hawaiian monk seal use of the west coast of the island of Hawaii between Kawaihae and South Point, and around Kaloko-Honokōhau National Historical Park. Pacific Islands Fisheries Science Center, PIFSC Internal Report, IR-06-014, Honolulu, HI

➤ Rahman MA, Uehara T, Pearse JS (2001) Hybrids of two closely related tropical sea urchins (genus Echinometra): evidence against postzygotic isolating mechanisms. Biol Bull 200:97–106

Rahman MA, Uehara T, Pearse JS (2004) Experimental hybridization between two recently diverged species of tropical sea urchins, *Echinometra mathaei* and *Echinometra oblonga*. Invertebr Reprod Dev 45:1–14

➤ Reed JM, Elphick CS, Oring LW (1998) Life-history and viability analysis of the endangered Hawaiian stilt. Biol Conserv 84:35–45

➤ Regis MB, Thomassin BA (1983) Structural anomalies in the spines of *Heterocentrotus mammillatus* (Echinodermata, Echinoidea) in an in vitro microcosm. Mar Biol 75:89–98

➤ Reyes-Bonilla H, Calderon-Aguilera LE (1999) Population density, distribution and consumption rates of three corallivores at Cabo Pulmo reef, Gulf of California, Mexico. PSZN I: Mar Ecol 20:347–357

➤ Ribes M, Coma R, Gili JM (1998) Heterotrophic feeding by gorgonian corals with symbiotic zooxanthella. Limnol Oceanogr 43:1170–1179

➤ Ribes M, Coma R, Gili JM (1999) Heterogeneous feeding in benthic suspension feeders: the natural diet and grazing rate of the temperate gorgonian *Paramuricea clavata* (Cnidaria: Octocorallia) over a year cycle. Mar Ecol Prog Ser 183:125–137

➤ Ribes M, Coma R, Atkinson MJ, Kinzie RA (2003a) Particle removal by coral reef communities: picoplankton is a major source of nitrogen. Mar Ecol Prog Ser 257:13–23

Ribes M, Coma R, Rossi S (2003b) Natural feeding of the temperate asymbiotic octocoral-gorgonian *Leptogorgia sarmentosa* (Cnidaria: Octocorallia). Mar Ecol Prog Ser 254:141–150

➤ Roman MR, Adolf HA, Landry MR, Madin LP, Steinberg DK, Zhang X (2001) Estimates of oceanic mesozooplankton production: a comparison using the Bermuda and Hawaii time-series data. Deep-Sea Res II 49:175–192

➤ Rosenfeld M, Bresler V, Abelson A (1999) Sediment as a possible source of food for corals. Ecol Lett 2:345–348

➤ Rossi S, Ribes M, Coma R, Gili JM (2004) Temporal variability in zooplankton prey capture rate of the passive suspension feeder *Leptogorgia sarmentosa* (Cnidaria: Octocorallia), a case study. Mar Biol

144:89–99

Scandol JP (1999) CotSim - an interactive *Acanthaster planci* metapopulation model for the central Great Barrier Reef. Prog Oceanogr 1:39–81

Smith JE, Smith CM, Hunter CL (2001) An experimental analysis of the effects of herbivory and nutrient enrichment on benthic community dynamics on a Hawaiian reef. Coral Reefs 19:332–342

Sorokin YI (1991) Biomass, metabolic rates and feeding of some common reef zoantharians and octocorals. Aust J Mar Freshw Res 42:729–741

➤ Stimson J, Cunha T, Philippoff J (2007) Food preferences and related behavior of the browsing sea urchin *Tripneustes gratilla* (Linnaeus) and its potential for use as a biological control agent. Mar Biol 151:1761–1772

➤ Taylor AH, Geider RJ, Gilbert FJH (1997) Seasonal and latitudinal dependencies of phytoplankton carbon-chlorophyll a ratios: results of a modelling study. Mar Ecol Prog Ser 152:51–66

Trites A, Heise K (1996) Marine mammals (in the southern BC shelf). In: Pauly D, Christensen V, Haggan N (eds) Mass-balance models of northeastern Pacific ecosystems. Fisheries Centre Research Reports, Vol. 4(1), Vancouver, BC

➤ Tsipoura N, Burger J (1999) Shorebird diet during spring migration stopover on Delaware Bay. Condor 101:635–644

➤ Tsounis G, Rossi S, Laudien J, Bramanti L, Fernandez N, Gili JM, Arntz W (2006) Diet and seasonal prey capture rates in the Mediterranean red coral (*Corallium rubrum* L.). Mar Biol 149:313–325

Tudman PD (2001) Modelling the trophic effects of fishing on a mid-shelf coral reef of the central Great Barrier Reef. BSc thesis, James Cook University, Brisbane, QLD

US FWS (2005) Draft revised recovery plan for Hawaiian waterbirds, second draft of second revision. US Fish and Wildlife Service, Portland, OR

Wada Y (1996) Marine mammals and birds. In: Pauly D, Christensen V, Haggan N (eds) Mass-balance models of northeastern Pacific ecosystems. Fisheries Centre Reports Vol 4(1), Vancouver, BC, p 69–73

Weijerman M, Beavers S, Marrack L, Most R (2009) Baseline assessment of the coral reef habitat in Kaloko-Honokōhau National Historical Park adjacent to the proposed harbor expansion and development, Kona Kai Ola. Cooperative Ecosystem Studies Unit, University of Hawai'i at Mānoa, Hilo, HI

Wolford JW, Boag DA (1971) Food habits of black-crowned night herons in southern Alberta. Auk 88:435–437

Würsig B, Wells RS, Norris KS (1994) Food and feeding. In: Norris KS, Würsig B, Wells RS, Würsig M (eds) The Hawaiian spinner dolphin. University of California Press, London, p 216–231

➤ Yahel G, Post AF, Fabricius K, Marie D, Vaulot D, Genin A (1998) Phytoplankton distribution and grazing near coral reefs. Limnol Oceanogr 43:551–563

➤ Zann L, Brodie J, Vuki V (1990) History and dynamics of the crown of thorns starfish *Acanthaster planci* (L.) in the Suva area, Fiji. Coral Reefs 9:135–144