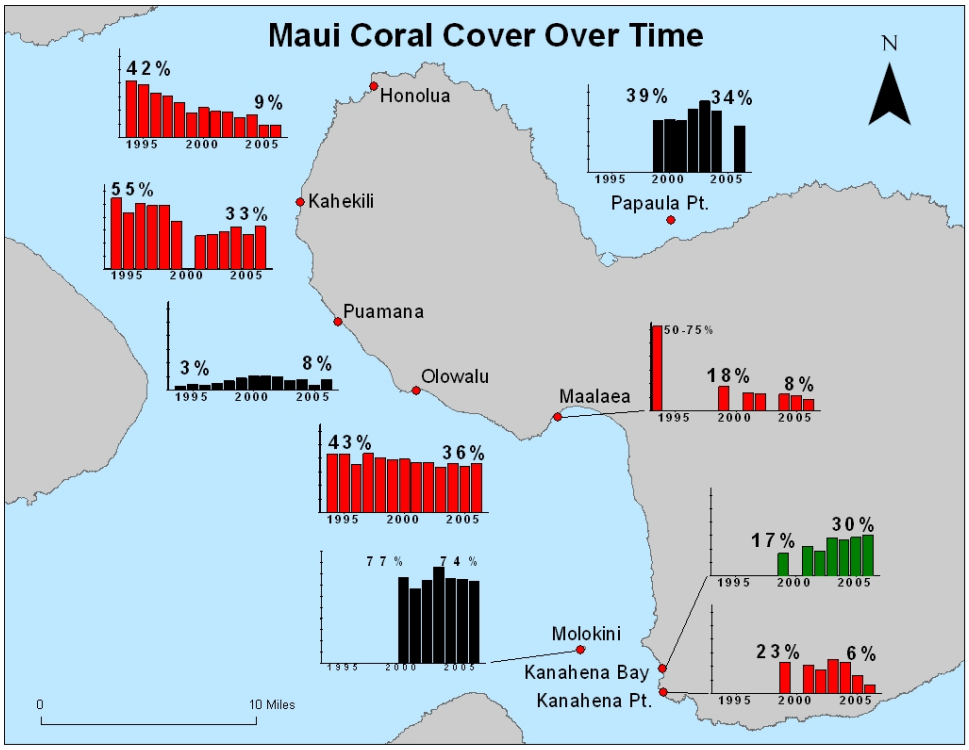
Status of Maui's Coral Reefs

In 1999, The Hawaii Division of Aquatic Resources (DAR) in partnership with the Coral Reef Assessment and Monitoring Program began annual surveys of coral condition at 9 reef areas in Maui County (see map ↓). The 4 West Maui stations had been previously monitored by the Pacific Whale Foundation since 1994. Those long-term monitoring programs provide an opportunity to assess the status and trends of Maui's coral reefs over the last 7 to 13 years.

Coral Status and Trends:

- Coral cover in 2006 ranged from 74% at Molokini to <10% at 4 sites: Honolua (9%), Puamana (8%), Maalaea (8%), and Kanahena Pt (6%).
- Coral cover increased at only 1 reef (Kanahena Bay, 17% to 30%), remained stable (<5% change), at 3 reefs (Molokini, Papaula Point, and Puamana), and declined at 5 reefs, most dramatically at Honolua (42% to 9%) and at Kahekili (55% to 33%).
- Mean coral cover of the 9 reefs declined from 35% when sites were first surveyed (1994 for West Maui, 1999 elsewhere) to 27% in 2006. Thus, nearly ¼ of all living coral was lost over that period.

Given the strong likelihood that several of the sites were already somewhat degraded when monitoring began, recent trends almost certainly underestimate declines over longer timeframes. For example, coral cover at the Maalaea site declined from 18% to 8% between 1999 and 2006, but a 1993 Fish & Wildlife Service study estimated coral cover there as being between 50% and 75%.



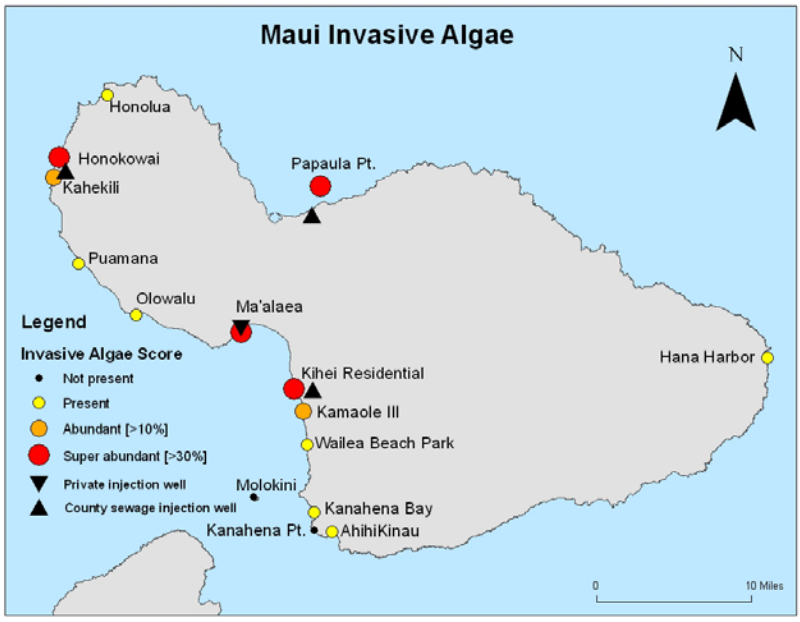
Trends in coral cover at 9 long-term monitoring stations. **Red** indicates >5% decline over monitoring period, **green** indicates >5% increase, **black** = no change (<5%)

The causes of coral reef decline around Maui are complex and vary among locations, but there are strong indications that human impacts have been very important. Notably, cover has declined at several West Maui sites: Honolua Bay, Kahekili, shallow reefs of Olowalu, and at Maalaea, where anthropogenic impacts from shoreline development and human use are likely greatest. Conversely, sites which have experienced increases or sustained high coral cover are remote or offshore (Kanahena Bay and Molokini). The one observed decline on a relatively remote reef (at Kanahena Point since 2004) was due to a local outbreak of the coral-eating crown-of-thorns starfish.

The Growing Problem of Invasive Algae

A significant and growing concern is the increasing overgrowth of reefs by invasive seaweeds, particularly *Acanthophora spicifera*, *Hypnea musciformis and Ulva* spp.. Shallow reefs in Kihei and Maalaea are now almost totally overgrown by those species and *A. spicifera* has become much more abundant in recent years at other locations including Honokowai/Kahekili and Papaula Point. Algal blooms are indicative of a loss of balance between factors which promote algal growth (e.g. nutrient availability) and those which control algal abundance (e.g. grazing). It is likely that both high nutrients & low grazing have been important:

- Studies by researchers from University of Hawaii (UH, next page), together with the evident correspondence between reefs with severe algal blooms and coastal areas with high human population density (see →), strongly suggest that elevated nutrients from wastewater or fertilizers are fueling accelerated algal growth.
- Reefs with abundant herbivorous fishes, such as those in the Honolua and Molokini MLCDs, have little or no invasive algae present, whereas reefs with depleted herbivore populations (e.g. Maalaea) are severely overgrown by algae.



Distribution of invasive algae around Maui: 'present' means invasive species found only in low abundance & in limited habitats, 'abundant' indicates cover of 10-30% on extensive portions of reef; 'super-abundant' means >30% algal cover in multiple reef zones

Invasive algae are by no means the only problems affecting Maui's coral reefs, In fact the greatest decline in coral cover observed on any surveyed reef was at Honolua Bay, where invasive algae are scarce, It is, therefore, important not to discount other potential factors such as increased sedimentation, chemical run-off and other pollution. However, the causes and consequences of invasive algal blooms are relatively well understood and therefore worth considering in some detail.

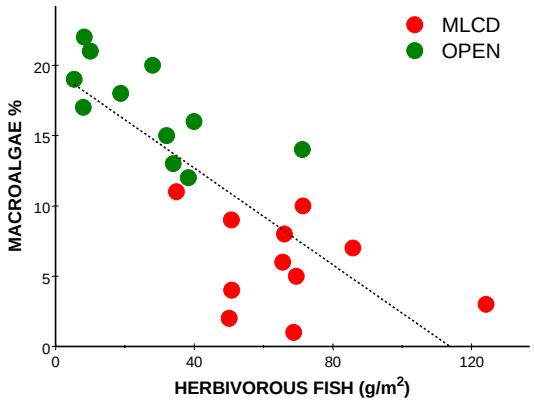
Sources and Consequences of Elevated Nutrients in Maui's Nearshore Waters

Recent research by UH scientists which has focused on shallow Kihei reefs which are currently overgrown by *Hypnea* and *Ulva*, strongly suggests that terrestrial, likely anthropogenic, nutrients are driving algal blooms there:

- Concentrations of nutrients (Nitrogen and Phosphorus) are highly elevated in nearshore areas where algal blooms are found.
- Stable isotope ratios (δ15N ‰) in algal tissue are indicative of animal waste (presumably sewage) being their primary source.
- Growth rates of algae on shallow reefs are extraordinarily high (*Hypnea* is able to double its biomass in just 2 days). Such growth rates are so high that the estimated productivity of shallow Kihei reefs is among the highest ever recorded for any ecosystem on the planet.

The Role of Grazing Fishes in Controlling Invasive Algae

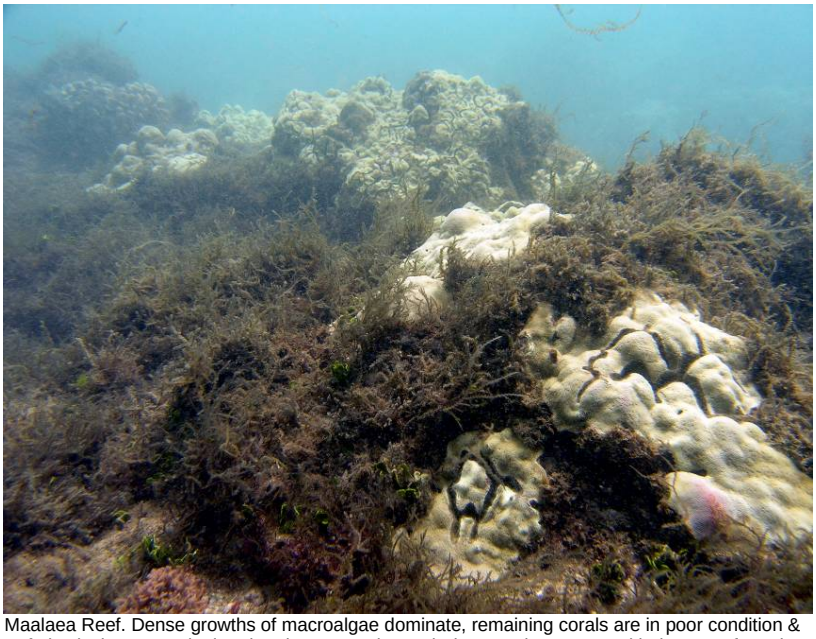
Clear evidence of the ability of grazing fishes (parrotfishes and surgeonfishes) to control the abundance of problem algae comes from the "Fish Habitat Utilization Study", a cooperative study by the National Oceanographic and Atmospheric Administration and Hawaii DAR. For that study, fish and habitat were surveyed in all of Hawaii's MLCDs plus comparable 'control' areas open to fishing. Among the findings were that, statewide, reefs with large stocks of herbivorous fishes tended to have much less macroalgae than reefs with low stocks of grazing fishes (see →). Supporting evidence for the capacity of grazing fishes to control the invasive seaweeds which are currently abundant on several Maui reefs comes from diet preference studies. Both *Acanthophora* and *Hypnea* are highly preferred foods for grazing fishes. In fact, *Acanthophora* has repeatedly been found to be among the most preferred foods for grazing fishes in studies both in Hawaii and elsewhere in the world. Therefore increases in stocks of grazing fishes would almost certainly lead to reductions in the spread and prevalence of invasive algae.



Relationship between biomass of grazing fish and macroalgal cover on 22 Hawaiian coral reefs. Red dots represents reefs closed to fishing (Marine Life Conservation Districts); **green** dots represent areas open to fishing

Case Study: Total System Collapse at Maalaea

The end result of reef degradation is evident at Maalaea Bay. In 1972, Maalaea coral reefs were described as being 'striking in their diversity and in the presence of rare corals species'. As late as 1993, estimated coral cover was 50-75% close to the site where cover is now 8%. Therefore, in just a few decades, the Maalaea reef has transformed from a healthy and diverse ecosystem into a badly degraded habitat overgrown by algae and with little surviving coral. One consequence of severe loss of living coral is that degrading reefs change from being actively-growing and structurally-complex habitats, into eroding and relatively flat areas which do not support abundant marine life. That process is well advanced at Maalaea, where fish stocks are now in very poor condition, being dominated by small wrasse, triggerfish and puffers. Given that the Maalaea reef is now a poor habitat for most grazing fishes, and that existing blooms of algae will continue to inhibit new coral growth, even in the best of circumstances (without water quality or fishing impacts), recovery of Maalaea would likely take many years.



Maalaea Reef. Dense growths of macroalgae dominate, remaining corals are in poor condition & reef physical structure is deteriorating as coral growth does not keep pace with the rate of erosion

Summary

It is very important to recognize that the kind of degradation which has occurred at Maalaea and elsewhere is not just a matter of loss of coral cover. Reductions in associated habitat quality and topographical complexity mean that once degradation is well established, affected reefs will have lower recreational and commercial value, and will support limited fish stocks, to the detriment of all resource users. The goal of those charged with the protection and restoration of Hawaii's natural resources must be to prevent such severe degradation from further affecting Maui's reefs. Given the trajectories of decline over the last 7-13 years, it is evident that substantial deterioration can occur rapidly. If steps are not taken to return conditions to those in which corals can thrive, it is nearly certain that additional reefs will reach the state of Maalaea. Recovery of herbivore stocks may be part of the solution at some locations, but without other steps to reduce land-based impacts there is unlikely to be substantial recovery across the island's reefs.

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