December 2, 2015

Land Use Commission
PO Box 2359
Honolulu, HI 96804
Fax: 808 587-3827
E-mail: luc@dbedt.hawaii.gov

Re: Testimony IN FAVOR of Final Environmental Impact Statement
Olowalu Town Master Plan (DKT. NO. A10-786)

Dear Land Use Commissioners,

I am writing to provide my support for the approval of the Final Environmental Impact Statement for the Olowalu Town Master Plan; DKT. NO. A10-786. I believe the EIS was performed professionally and support the project for the much needed housing it will create.

The Olowalu Town plan is designed to be a complete community based on a zoning model that is different than the standard zoning code used with most recent developments. This flexible zoning code allows construction of towns similar to Maui’s historical towns. This flexibility allows for apartments, multi-family units, live-work units, senior housing, and single family housing to co-exist along the same street. This wide variety of housing types will meet the needs of Maui’s families throughout their lives as incomes and family needs change with life.

The majority of the housing units within Olowalu are planned to be apartments, multi-family units, and small single family units. These housing types have a smaller footprint which allows the cost of the infrastructure to be much less than standard single family homes in many of the new subdivisions. The result is lower cost housing options for Maui’s families which is sorely needed. Similar to the way most of the multi-family units in Wailuku are affordable to Maui residents even without government restrictions, most of the housing in Olowalu will be affordable to Maui residents due to the type of housing to be constructed.

It is my understanding that a Final Environmental Impact Statement is utilized to disclose potential impacts for a proposed development. The Olowalu Town Final EIS utilizes many professionals in their various fields of expertise to provide information about the impacts of the Olowalu Town Master Plan.

It is not surprising that some members of the community do not agree with everything within the document. In fact, it would be impossible to create a document in which someone would not disagree. However, this Final EIS is a complete disclosure document that is well prepared and thorough. If this document is not acceptable, I fear that the system will not allow for worthy projects to progress through the review system which will be detrimental to Hawaii moving forward.

Please approve the Olowalu Town Final Environmental Impact Statement.

Very truly yours,

BLACK DEVELOPMENT CORPORATION

Michael J. Fergus
President
Fwd: 25 reasons why the proposed Olowalu Town is a bad idea
otaheiteshopify
to:
luc
12/03/2015 09:00 PM
Hide Details
From: otaheiteshopify@gmail.com
To: luc@dbedt.hawaii.gov

Aloha LUC commissioners.
I'm forwarding this article to you that states 25 reasons why the LUC should reject the FEIS for the Olowalu Town Development. This article addresses many of the community concerns.

Mahalo
Tiare Lawrence

**Save Olowalu! 25 reasons why the proposed Olowalu Town is a bad idea**


MAUI TIME  DECEMBER 2, 2015
BY ANTHONY PIGNATARO  21 COMMENTS
A few weeks ago the state Land Use Commission LUC met at the Maui Arts & Cultural Center to discuss the final environmental impact statement (EIS) for Olowalu Town, a massive development project pushed by Bill Frampton and Dave Ward. The project is billed as a “complete community”—containing its own housing, public infrastructure, recreation, commercial development and open space. The LUC didn’t decide the fate of the EIS (or the project), but will meet again at the MACC on Dec. 7 to take it up again.

Given that the project has been in development for the last decade, there’s a considerable cache of documents that outline more than a few concerns. In fact, they catalog a very long list of pretty substantial problems. While the list below is by no means a comprehensive list of everything that’s wrong with the proposed Olowalu Town—that would take something approximating a second environmental impact statement—it does include a lot of issues that might doom the plan. For more information, check out SaveOlowalu.org.
1. Olowalu Town will include approximately 1,500 homes.

2. That means about 4,000 residents would live there.

3. Olowalu’s current population, as of the 2010 census, is 80.

4. The project is so big that it will require the relocation of Honoapiilani Highway as it travels through Olowalu.

5. Though billed as a way to address Maui’s housing need, the project will actually build too much housing for West Maui. “The project will exceed the [Planning] Department’s estimated housing need and provide a rationale for exceeding the demand,” Planning Director Will Spence said in an April 17, 2012 letter to developers Bill Frampton and Heidi Bigelow.

6. Developers bill the project as a “Smart Location” under LEED Neighborhood Development standards. This simply means that it encourages the building of neighborhoods near already existing public transportation. The county’s Planning Department took issue with this, in its April 17, 2012 letter to Frampton and Bigelow. “Please justify how this project, located four miles away from the edge of Lahaina, meets ‘Smart Location’ for LEED Neighborhood Development standards,” Spence wrote. In their response written three years later, developers Frampton and Ward denied that this was a problem and insisted that “Olowalu has historically been used for housing.”

7. The Draft EIS, issued in 2012, states that “As recently as the 1930’s, Olowalu was a thriving plantation town.” According to the county Planning Department, this isn’t even close to true. “Throughout its history, Olowalu was at most a ‘camp’ and at most a ‘village,’” Spence wrote in his April 17, 2012 letter. “In 1930, census-taker Kenichi Takayama recorded the population of Olowalu as being 447 persons.” Spence helpfully offered to Frampton and Bigelow that the county has “extensive information about West Maui’s camps, villages, and towns, including Lahaina, Olowalu, Puukolii, and Ukumehame if you would like further clarification.”

8. Most of the maps included in the EIS aren’t to scale. “[A]lmost all maps say “Not To Scale” which makes it difficult to determine distances among and between uses,” the State Office of Planning (OP, which advises the LUC) said in a Nov. 17, 2015 letter to the LUC. “The Conceptual Master Plan map in particular, should be to scale.”

9. The public has never given a chance to review the developers’ complete Traffic Impact Analysis Report, which the state OIP told the developers to prepare back in 2012. “Given the significance of the issue and extensive revisions made following the “Preliminary” TIAR, the public should be given the opportunity to review this final TIAR,” the state Office of Planning said in their Nov. 17, 2015 letter.

10. Archaeological studies and surveys “for the entire Olowalu area were not included in the Draft FEIS,” stated the OP on Nov. 17, 2015. This is concerning because “new sites and cultural material have been found” in recent surveys and the State Historic Preservation Division (SHPD) “has not reviewed and commented
on the Draft EIS,” according to the OP’s Nov. 17, 2015 letter.

11. The project will use a lot of water. The EIS approximates the water use at about 750,000 million gallons per day (gpd). But five years ago, the county’s Department of Water Supply put the estimate at closer to “between approximately 900,000 and a little more than 2 million gpd, according to system standards,” according to an Aug. 5, 2010 letter from then-Water Supply Director Jeffrey Eng to Colleen Suyama, a consultant who was preparing the Olowalu EIS. In that letter, Eng also dryly noted that “as of 2008, the sustainable yield set by the Commission on Water Resource Management for the Olowalu aquifer is 2 million gallons per day.”

12. The project will draw water from state lands. “Source of surface water is state lands,” states a handwritten note on a Mar. 20, 2012 memo from the state Department of Land and Natural Resources. “Applicants need to work towards getting a water license and license to access state lands.” More than three years later, on Oct. 26, 2015, Colleen Suyama replied, stating that “We further acknowledge that the source of surface water is State lands. As required, the applicant will obtain a water license and lease to access State lands.”

13. The project will also consume a great deal of agricultural land. And the County of Maui doesn’t like that. “[T]he DEIS inadequately justifies the removal of 621 acres of agricultural land, including 121 acres of Prime Agricultural Land,” Spence wrote in 2012. “Suggesting that these 621 acres are a small percent of Maui’s Agricultural lands neglects the fact that these are prime lands that demand special protection.”

14. What’s more, the lands the developers have set aside for ag are some of the lowest quality in the area. “[T]he majority—80 percent—of the Master Plan Site Area has ‘A’ and ‘B’ classified soils, while about 19 percent of the site is of the lowest, least productive classification ‘E,’” Spence noted in his April 17, 2012 letter. “It is noted that this area where the least productive AG soil exists is the area surrounding the Olowalu Stream—the precise area where the Master Plan proposes to retain as AG land within the Olowalu Cultural Reserve.” In their response submitted three years later on Oct. 26, 2015, Olowalu Town developers Frampton and Ward argued that “farming is not the sole means of improving or increasing the long-term sustainability of Hawaii’s economy” and that “providing homes” could also do wonders. They developers also noted that greenhouses and hydroponic farming are making great strides today.

15. Though they included no detailed protection plan in their EIS, developers insist that “Olowalu Stream will not be altered during implementation of the Master Plan.”

16. According to county Planning Director Will Spence (who noted this in his 2012 letter), the project exists in a “known tsunami and flood hazard area.” In their 2015 response to Spence, the developers said that their “proposed drainage improvements” would “reduce the potential for flooding.”

17. Nene—an endangered species—are found in Olowalu, yet the EIS (as the County of Maui noted in 2012) contains no explanation as to how developers will protect the species. In 2015, the developers responded to the county’s concerns by reiterating that their project wouldn’t harm the birds.
18. The coral reef off Olowalu is one of the healthiest on Maui—perhaps in the entire state. Biologist Pauline Fiene noted this in her 2012 comments on the EIS. “We don’t get to decide where our special natural places are on Maui,” she wrote. “Nature decides that. All we can decide is where our development is going to be. And if there were a reef on the whole island that cries out for respite and exemption from urban development above it, it would be Olowalu. It has developed over centuries and there is literally nothing to replace it.” For this reason, Fiene noted, she was “baffled” as to why a project on this scale was even being considered for Olowalu.

19. In 2015, the project developers reiterated, despite the concerns of Spence and biologists like Fiene, that Olowalu Town “is not expected to adversely affect the reef environment and nearshore water quality.” Big wave surfer and former Maui County Ocean Safety supervisor Archie Kalepa didn’t buy it. “If they develop Olowalu into a community and a hotel, the effect it will have on that ecosystem—the waterfront and the reefs—will be such a great impact that it will socially ruin that reef,” he said. “When I say ‘socially,’ I’m talking about the fishes, the sharks, all the marine life that exist… Olowalu’s one of the few places we have left. I don’t think that from an environmental standpoint that it’s a good idea for us to develop that area.”

20. Though the EIS notes that Olowalu’s irrigation system is “quite dated, with portions of it built in the late 19th and early 20th centuries,” it neither identifies the system’s location on its maps nor acknowledges that its age may qualify it for listing on the National Register of Historic Places—which Spence said in 2012 may “have an adverse impact on this resource,” as it would require additional protections during the project’s development.

21. The EIS, Spence noted, contains no specific information on how the project will impact police, fire and solid waste services. “It is insufficient to merely state that the hospital or police facilities are located a certain distance from Olowalu, or that a fire station site will be discussed for possible inclusion in the public/quasi-public area,” Spence noted in 2012.

22. Though Olowalu sits astride the only road between Lahaina and Ma’alaea, the county Planning Department noted that the project EIS doesn’t evaluate the project’s traffic impacts (or what might mitigate those impacts) to those two towns.

23. The project also includes 375,000 square feet of commercial development. To put this figure into perspective, the new Target in Kahului covers 140,000 square feet.

24. In 2012, Spence noted that the project EIS “underestimates” costs to county in terms of police, fire, civil defense, housing and human concerns, public works and planning. It also underestimates costs to the state in terms of education, medical, prison and highway services.

25. Based many of these concerns (as well as others), the state Office of Planning concluded in its Nov. 17, 2015 letter that the LUC not approve the Olowalu Town EIS.
Cover design: Darris Hurst
Cover photo: Chris Archer
December 3, 2015

Hawaii Land Use Commission

Subject: Recommending LUC deny Olowalu Town FEIS

Dear Commissioners,

I am a marine biologist with over 20 years of research on Hawaii’s marine environment including my doctoral work with the University of Hawaii studying the Olowalu manta ray population. Based on my review of the marine report conducted by Marine Research Consultants, Inc., I strongly recommend denying the FEIS. I address the Summary section of the report beginning on page 25 to support my basis for the denial. The numbers below refer to the numbers in the summary (Appendix A).

1. The report states, “60 water samples that were collected at five ocean sites spaced within the project boundaries”. At each site only a single sample was taken therefore there is no information about sample variance and 60 samples are way to few samples to be characterize the Olowalu Reef area.

2. The report states, “In all cases, the near shore zone of mixing was restricted to a narrow zone that extended a maximum of only tens of meters from the shoreline. Beyond this distance, water chemistry at all sites was representative of pristine open coastal waters”. Plenty of photos demonstrate that mud water entering the ocean during a heavy rain event can extend several hundreds of meters offshore (Appendix B). The existing sediment stress on the inshore reef at Olowalu extends several hundred meters offshore. The statement is not representative of mixing that can occur during heavy rain events.

5. The report states, “Ground-truth data and resulting computer generated maps provided estimates of occurrence of living coral cover, as well as cover of algae, sand and mud throughout the various zones of the reef environment.” Less than 1% of the reef was surveyed and carried out in a haphazard way (Appendix C). Much more of the reef needs to be surveyed using a systematic design. The characterization needs to also be three dimensional since a coral 2 meters tall will be characterized in the same manner as a coral that is 2 inches tall when each has very different value and provides very different ecosystem services. This type of characterization cannot be done using general coral cover maps. Since the surveys were carried out in 2010, there has been a significant sediment stress impact to the inner reef from the removal of kiawe trees that destabilized the shoreline and eliminated a fish nursery area, and the construction of three oceanfront homes, two of which cited for BMP violations (Appendix D). All this in addition to the recent mass coral bleaching event over the past few months has significantly altered the reef character since the survey was carried. To obtain a true baseline, a new
A survey should be conducted using an appropriate survey design and quantify the recent sediment impacts on the inshore reef in front of the recent oceanfront built homes as a reference and scale that impact to account for 1,500 homes, 800 ohanas, a sewage treatment plant, a shopping mall and 4,000 new residents.

6. The report states, “Macroalgae accounted for about 8% of bottom cover, 21% of the bottom was covered with sand, and 33% of the bottom consisted of mud and sediment bound in algal turf”. Given the sediment damaged has changed significantly since the survey was conducted, these numbers are not valid.

11. The report states, “Overall, results of this study indicate that the existing episodic discharge to the ocean of land-derived sediment is the most pervasive stress to the reefs off Olowalu. However, the area extent of such deposition is limited and does not affect all areas of the reef”. Why is there no assessment of how far offshore the sediment stress is impacting to provide some context for the extent of sediment stress?

12. The report states “Depiction of the existing marine environment indicates that, at present, groundwater is so restricted in distribution that there is essentially no effect on marine community structure.” There are many groundwater seeps as far as 100 yards offshore that aren’t being accounted for (personal experience). The sampling design was too small an area, insufficient samples per site to control within sample variability and to temporal sampling to control for across day variability, for example after a rain event or during tree removal and grading to clear a lot for development.

13. The report states “while the project will increase the area of impervious surfaces, the inclusion of retention basins is predicted to result in no change to discharge of water to the ocean compared to the present scenario. However, with respect to impacts to coral communities, the most important aspect of the retention basins is a potential reduction in discharge of terrigenous sediment”. Theoretically, proper implementation and management of sediment basins should greatly reduce sediment discharge but this is the exception rather than the rule. The Mahana Estates project at Kapalua is a clear example where Marine Research Consultants also claimed that no impact would occur to the marine environment due to the proper use of BMPs. There have been well over 50 mud water events stemming from that construction project over the past 3 years, multiple BMP revisions and a 5-month stop work order. To this day they are still unable to properly control the sediment discharge from their property and into the ocean. Many other similar examples exist throughout Maui where developer with good intentions ultimately destroyed the reef ecosystem offshore from their project. The grading of 432 acres uphill from the reef will surely result in sediment depositing on the reef and therefore should be discussed as a probably impact and present alternatives to minimize and mitigate those impacts.
14. The report states “as long as best management practices are utilized to avoid any unforeseen impacts during the construction and operational phases of the project, and engineering considerations in the design of the retention basins focus on maximizing sediment trapping, there is no rationale to indicate the potential for negative impacts to the marine environment”. Any references to coastal development having a positive impact to an adjacent reef are not listed (Appendix E), probably because they don’t exist, but plenty of references exist to show the contraire (see Appendix F). The rationale to indicate the likelihood for negative impacts are that every coastal development in Hawaii has had a negative impact on the offshore coral reef and that BMPs have proven to be a dismal failure at preventing sediment discharge from a construction site. Since sediment impacts are very likely going to occur, this EIS needs to describe what will be the impact with respect to the loss of ecosystem services from the coral reef, impacts to fishers, cultural practitioners, recreational users and commercial users. The EIS should state what mitigation measures it will take to replace any loss of coral.

15. The report states, "The studies conducted for this report, particularly the water quality analyses and coral reef habitat maps, can serve as an initial baseline for any monitoring programs that may be required for the project". As stated earlier, the recent sediment impacts for the coastal disturbance of vegetation and the mass coral bleaching event warrants a new baseline characterization study. The existing baseline survey can be used to quantify the impacts that have occurred in the past 5 years since the survey was conducted.

Furthermore, in a letter by Dr. Steven Dollar dated September 28, 2015 he states “my study methodology and outcomes should not be affected by the alternative land use configurations offered by Alternative 1 and Alternative 2” referring to the alternative to develop on the makai side of the highway. Common sense tells us that the closer a pile of dirt is to the ocean, the more likely wind and water will carry it into the water. The main reason that the GPAC, the Maui Planning Commission, and the Maui County Council decided to remove the makai lands from the Olowalu Town proposal was to provide a buffer area where storm water and sediment could settle out before reaching and impacting the coral reef. For Dr. Dollar to imply that the impacts to the marine environment would be the same (improved reef health) under either scenario is disturbing.

I wish to thank all the Commissioners for your public service and strongly urge you to deny the Olowalu Town FEIS on the grounds of “failing to fully declare the environmental implications of the proposed action and discussing all relevant and feasible consequences of the action”, a legal requirement for an EIS.

Sincerely,
Mark Deakos, Ph.D.
4993 Lower Honoapiilani Road
Lahaina, Hawaii 96761

Attachments:
    Appendix A
    Appendix B
    Appendix C
    Appendix D
    Appendix E
    Appendix F
V. SUMMARY

1. Evaluation of the nearshore marine environment off the Olowalu Master Plan project site in West Maui was carried out in 2010-2011. Assessment of nearshore marine water chemistry was carried out by evaluating data from 60 water samples that were collected at five ocean sites spaced within the project boundaries. Water samples were collected on transects perpendicular to shore, extending from the shoreline to distances of approximately 500-600 m offshore. Analysis of fourteen water chemistry constituents included all specific constituents in DOH water quality standards.

2. Several dissolved nutrients (Si, NO$_3^-$, PO$_4^{3-}$, TN and TP) displayed strong horizontal gradients at several ocean transect sites with highest values closest to shore and lowest values at the most seaward sampling locations. Correspondingly, salinity was lowest closest to the shoreline and increased with distance from shore. These gradients were most pronounced at the northern boundary of the project site and weakest at the southern region of the project area southwest of Olowalu Point. These patterns are indicative of groundwater efflux at the shoreline, producing a zone of mixing where nearshore waters are a combination of ocean water and groundwater. In all cases, the nearshore zone of mixing was restricted to a narrow zone that extended a maximum of only tens of meters from the shoreline. Beyond this distance, water chemistry at all sites was representative of pristine open coastal waters.

3. Water chemistry constituents that are not major components of groundwater also displayed distinct gradients with respect to distance from the shoreline. In particular, Chl a and turbidity were generally elevated in nearshore samples with decreasing values moving seaward.

4. Application of a hydrographic mixing model to the water chemistry data was used to indicate if increased nutrient concentrations in nearshore waters are the result of mixing of natural groundwater with oceanic water, or are the result of inputs from activities on land. The model indicated that, at the time of sampling, there was a distinct subsidy of nitrate nitrogen (NO$_3^-$) to the ocean at survey sites located near the northern boundary of the property (Site 1) and off the eastern side of Olowalu Point (Site 4). There was no external supply of nitrate at Site 2, located directly off Olowalu Stream. However, there was a subsidy of phosphate phosphorus (PO$_4^{3-}$) off Olowalu Stream, which did not occur at any other
location.

5. Evaluating water chemistry from the single sampling in 2010 using DOH specific criteria for Open Coastal Waters indicates that many of the measurements in the nearshore areas (within 10-20 m of the shoreline) exceed standards, particularly for various forms of nitrogen. As these standards do not take into consideration of mixing of high-nutrient, naturally-occurring groundwater with ocean water in the nearshore zone, such exceedances are expected.

6. Characterization of the marine habitat and biotic community structure was carried out using a fully georeferenced WorldView-2 multispectral satellite image of the Olowalu area purchased from the Image Library at DigitalGlobe.com (image data originally acquired on February 10, 2010). Ground-truth data derived from georeferenced digital photographs collected at 200 representative points provided the input to create benthic habitat maps of the Olowalu reefs. Ground-truth data and resulting computer generated maps provided estimates of occurrence of living coral cover, as well as cover of algae, sand and mud throughout the various zones of the reef environment.

7. Analysis of spectral data within the satellite image was classified using georeferenced ground-truth data and covered an area of about 1.8 million square meters, or 454 acres. Overall coral cover in the mapped area was about 37% of bottom cover, while living coral cover within the calibration photo-quadrats equaled about 40% of bottom cover. The difference in cover values using the two estimates is a result of selection of calibration-validation points that are likely biased toward areas of higher coral cover. Macroalgae accounted for about 8% of bottom cover, 21% of the bottom was covered with sand, and 33% of the bottom consisted of mud and sediment bound in algal turf.

8. In most open coastal areas of Hawaii the dominant factor responsible for the physical structure of reefs and species assemblages is stress from wave energy. The reefs at Olowalu are somewhat unique in that sediment deposition (or lack thereof), rather than wave forces, appears to be the major determinant of physical and biotic reef structure. Along the northern side of Olowalu Point, deposition of terrigenous sediment emanating from Olowalu Stream creates a habitat where coral communities are limited to species and growth forms that can withstand the sub-optimal conditions created by sediment deposition. South of Olowalu Point, a shallow, wide, triangular-shaped reef flat, formed from deposition of alluvial material from Olowalu Stream, terminates in a fore-reef composed of actively accreting corals assemblages that show little or no effect of sediment stress. Reefs at that southeastern end of the project site (14-Mile Marker) also showed distinct indications of sediment stress, although no major streams discharge regularly in this area.

9. Mobile macro-invertebrates on the reef consist primarily of several species of sea urchins. These species include the bio-eroding burrowing urchins Echinometra mathaei and Echinostephus acicularis, and the larger slate pencil urchin (Heterocentrotus mamositatus), the collector urchin (Tripneustes gratilla) and the long-spined urchin (Echinothrix diadema). Urchins were rare in the zones covered by sediment. Other macrobenthos observed consist of sea cucumbers, primarily on the sandy areas of the reef flats, and starfish. The coral-eating crown-of-thorns starfish (Acanthaster planci) was not observed in the study area.
10. Populations of reef fish in the area were typical of Hawaii reefs, although numbers of larger fish were low, likely as a result of fishing pressure. The most abundant families consist of wrasses, damselfish and surgeonfish. As is generally the case, density of fish was a function of vertical complexity of the benthic surface, with the highest abundance on the outer fore-reef. Reef fish were rarest in the areas with heaviest deposition of mud. Numerous small sharks were observed on the inner reef flat south of Olowalu Point.

11. Overall, results of this study indicate that the existing episodic discharge to the ocean of land-derived sediment is the most pervasive stress to the reefs off Olowalu. However, the area extent of such deposition is limited and does not affect all areas of the reef. Reef communities on the outer reef flat and fore reef represent essentially pristine ecological settings unaffected by most activities of man (with the exception of fishing).

12. Engineering analysis indicates that, with full build-out of the planned project, there will be changes in groundwater that include a small reduction in flow rate and phosphorus discharge and an increase in nitrogen discharge to the nearshore ocean compared to present conditions. The changes with combined groundwater and surface runoff from episode storm events, is predicted to increase both phosphorus and nitrogen flux to the ocean by small amounts. Depiction of the existing marine environment indicates that, at present, groundwater is so restricted in distribution that there is essentially no effect on marine community structure. Thus, the small changes in groundwater dynamics projected to result from the project do not present a mechanism for future negative effects to offshore marine communities.

13. A planned component of the Olowalu Town Master Plan is a series of retention basins within the project site for the purpose of retaining storm water runoff prior to discharge to the ocean. While the project will increase the area of impervious surfaces, the inclusion of retention basins is predicted to result in no change to discharge of water to the ocean compared to the present scenario. However, with respect to impacts to coral communities, the most important aspect of the retention basins is a potential reduction in discharge of terrigenous sediment.

14. Planning of the Olowalu Town Master Plan focuses on continued maintenance and stewardship of the unique natural resources of the area. As a result, as long as best management practices are utilized to avoid any unforeseen impacts during the construction and operational phases of the project, and engineering considerations in the design of the retention basins focus on maximizing sediment trapping, there is no rationale to indicate the potential for negative impacts to the marine environment.

15. The studies conducted for this report, particularly the water quality analyses and coral reef habitat maps, can serve as an initial baseline for any monitoring programs that may be required for the project.
Appendix B: Mud Water Photos
Appendix C: MRC Report Survey Areas
Appendix D: Olowalu BMP Violations

24 June 2014

24 June 2015
### Request Information

**Status:** Done  
**Received Date:** 06/29/2014  
**Completed Date:** 07/16/2014  
**Duration (Days):** 17  
**Entered By:** KIVANET

**How Taken:** REMOTE  
**Source:** INTERNET

**Requestor Information**

**Name:** TRACY ADAMS  
**Address:**  
**Company:**  
**E-Mail:** tracva808@gmail.com

**Phone:**  
**Home:** 808-366-8822  
**Work:**

**Event Location**

**Address:** 11501 HONOAPIILANI HWY  
LAHAINA, HI 96761  
**TMK:** 2480030460000  
**Owner(s):** MARTIN, PETER KLINT TRUST

**Subdivision:**  
**Intersection:**  
**Common Place:**  
**Other Location:** HOUSE UNDER CONSTRUCTION, OCEANFRONT, OLOWALU

**Memo(s)**

House with TMK (2) 4-8-003:046. This house (property line approximately 100 yards from the ocean) is under construction and the BMPs are inadequate (single silt fence almost completely collapsed and non-functional) and threaten the offshore reef should a heavy rain event occur. Photos are available of the violation upon request. Please double check the address and TMK to be sure they are valid. Very few houses under construction in this area so the one in violation should be obvious.

**Additional Addresses**

**Address:**  
**TMK:**

**Related Permit(s)**

**Permit**  
**Permit Name**  
**Status**

**Inspection Information**

**Problem**  
**Type**  
**Scheduled**  
**Completed**  
**Inspector**  
**Result**

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RF#1: 14-0000860  
TMK#: 2480030460000

Page 1 of 2
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- **(H) Phone:** 808-366-8822
- **(W) Phone:**

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RFS #: 14-0000860  TMK #: 2480030460000
VI. REFERENCES CITED


Appendix F: Literature on Reef Impacts

**POSITIVE Impacts of coastal development on Reefs:**

*No literature found.*

**NEGATIVE Impacts of coastal development on Reefs:**

From Urbanization


From Nutrient Loading


From People


**From Sediment**


**From Urban Development**


To: luc@dbedt.hawaii.gov

Subject: A10-786 Olowalu Town - Testimony on the Final EIS

November 16, 2015

Dear LUC Commissioners,

In reviewing the materials associated with the Final Environmental Impact Statement (FEIS) for the proposed Olowalu Town development, it appears that many of the comments and concerns submitted in 2012 by my colleagues in the science and conservation community were dismissed outright through the responses provided by the developers and contractors. In some cases, the responses are erroneous and could be considered irresponsible from a scientific standpoint. In other cases, descriptions of proposed mitigation measures, such as the implementation of Low Impact Development (LID) strategies to reduce runoff and sedimentation are certainly admirable, though vague in nature and lacking any meaningful metrics for evaluation. It is my opinion that the apparent lack of rigor in the assessment of the marine environment, coupled with the lack of detail pertaining to the proposed LID measures and other Best Management Practices (BMPs), provide sufficient justification for you to reject the Final EIS for the proposed development.

Hawaii Administrative Rules (HAR 11-200) state that an Environmental Impact Statement “shall fully declare the environmental implications of the proposed action and shall discuss all relevant and feasible consequences of the action.” The FEIS does not sufficiently meet these criteria for either of the two aforementioned issues my testimony focuses upon.

Regarding the assessment of the marine environment, I urge you to seriously consider the testimony submitted by seven highly credentialed marine biologists from the Scripps Institution of Oceanography (testifying as individuals), who have collectively spent thousands of hours conducting research at Olowalu, one of their field sites. They found that the FEIS contains flawed methodology, sampling errors, and inaccurate conclusions, and therefore cannot sufficiently address the environmental implications or consequences of the proposed development.

In reviewing Appendix C-2 (Stormwater Quality Enhancements), and other sections of the EIS that reference mitigating the impact of runoff through BMPs and LID, I was unable to find key details about the proposed measures, specifically their respective contributions to pollutant load reduction during both the construction and post-construction phases of the development. The FEIS names the types of LID and BMP measures being considered, describes their function and benefits, and notes the broader categories of the areas within the development where each could be implemented (i.e. “Single-Family Residential” or “Commercial”), but this information alone does not sufficiently address the environmental impact of these measures. This lack of detail is concerning, as
there is no attempt to provide location siting of specific LID measures within the development, or quantify the amount of nutrients (mg/L of nitrogen and phosphorous) or sediments (mg/cm²/day) that these measures will reduce.

The FEIS also indicates that “Olowalu Town will develop stormwater BMP guidance documents for use by the designers of residential, commercial, public, and green space/recreational facilities within the community.” It is unclear whether developing and providing these documents would be considered “recommendations” or “requirements” for the implementation of specific stormwater control measures, and there is also no indication of oversight and accountability mechanisms to ensure these measures are appropriate, adequate, and implemented properly.

Many of the proposed stormwater management strategies and examples of BMPs represent innovative technologies that have been in use elsewhere for a long time, and have been advocated for use in Hawai‘i for many years by numerous individuals, agencies, and organizations. Only relatively recently have development projects in Hawai‘i begun to implement these measures, and some have yet to be tried on Maui at all, much less at the scale proposed. The FEIS references the West Maui Ridge to Reef Initiative’s advocacy for LID measures, but it should be noted that those underway are still considered to be pilot or demonstration projects, such as rain gardens and curb inlet baskets. Maui-specific challenges and barriers to the effective implementation of these and other strategies are only now emerging, and their effectiveness has not been sufficiently measured, demonstrated, and evaluated at this stage.

Given these realities, along with the obvious history of stormwater runoff impacts to Maui’s reefs due to coastal development, I feel that the flaws and lack of detail in the FEIS present a clear case that Olowalu should not be used as a test ground for these technologies, especially when considering the uniqueness and vulnerability of the coral reef ecosystem, its ecological, economic, and cultural importance, and its sensitivity in the face of global climate change on top of the local stressors it already endures. Please reject the Final EIS for the Olowalu Town development.

Thank you for your consideration.

Sincerely,
Liz Foote

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B.S., Ecology, Behavior and Evolution, University of California, San Diego
M.Sc., Science Education (Marine Science emphasis), Oregon State University
Reed M. Ariyoshi  
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Wailuku, HI 96793  

December 3, 2015  

Land Use Commission  
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Honolulu, HI 96804  
Fax: 808 587-3827  
E-mail: luc@dbedt.hawaii.gov  

Re: Testimony IN FAVOR of Final Environmental Impact Statement  
Olowalu Town Master Plan (DKT. NO. A10-786)  

Dear Land Use Commissioners,  

I am writing to express my support for the approval of the Final Environmental Impact Statement for the Olowalu Town Master Plan; DKT. NO. A10-786. I have reviewed the Final EIS for this project and believe that the document is very concise, thorough and covers all aspects of the proposed project.  

It is my understanding that the purpose of a Final Environmental Impact Statement is to analyze and disclose potential impacts for a proposed development. The Olowalu Town Final EIS utilizes the services of many reputable professionals in their various fields of expertise to provide information about the impacts of the Olowalu Town Master Plan.  

It is not surprising to find that some members of the community do not agree with everything contained within the document. In fact, it would be nearly impossible to create a document for a project of this magnitude in which there is total agreement within the community. However, it is my opinion that this Final EIS represents a complete disclosure document that is very well prepared and thorough. If this document is deemed not acceptable, I am afraid that the current system will not allow for worthy projects to progress through the review process, which moving forward, will ultimately prove to be detrimental to our State.  

It is my hope that you will approve the Olowalu Town Final Environmental Impact Statement.  

Very truly yours,  

Reed M. Ariyoshi
This is my testimony in favor of final EIS for Olowalu Town Master Plan

Aloha Land Use Commissioners,

I humbly ask for your approval of the Olowalu Master Plan. I grew up on Maui, fourth generation Jamaicans family that grew up in the sixth increment in Kahului. I grew up in a master planned community that was developed for the sugar cane industry on Maui. It was like growing up in a wonderfully planned village. The often repeated phrase it takes a village to raise a child, I grew up in that village. I have wonderful memories living in the plantation style homes in the 60's and 70's.

Looking back at the changes to Maui both good and bad, I wish more people had the vision to create smart plans like this vision for Olowalu. This plan keeps Maui alive by allowing future generations to experience the closeness of growing up around towns like Makawao, Paia, and like the Olowalu of past generations. The Olowalu Master Plan is a great plan to recreate the old town feel that we have been losing on Maui with the modern improvements needed for the area.

Building the right mix of homes will allow a once beautiful town to exist once again. Even more precious is to bring back the old Maui families to the the area and allowing the future generations to grow up in a Maui that we were lucky to experience.

My Dad worked for Waihee Dairy as a delivery driver in the days milk was delivered to your home. We delivered milk all over the island and one of our weekly stops was the Olowalu store. At the time there were more homes in the area, a nice community and the store was the gathering place for everyone. Everyone knew each other and when we came to deliver the milk it was like visiting family.

When my daughter was a youngster, we would get up early during the summer and winter breaks to dive or dawn patrol surf at Olowalu. Some of my fondest memories was heading back to the Olowalu Store before lunch to eat those red hot dogs and shaved ice on the tailgate of my pick up truck to laugh and share stories. Yes, I have many fond memories of this area.

Unfortunately, the ocean and shoreline conditions are progressively deteriorating. The area needs to be modern solutions before the conditions created from centuries of sediment runoff completely destroy the reefs. Hopefully, over time this condition can be reversed by modern drainage options that filter the runoff before entering the ocean. This plan has solutions to stop the current problem from progressing.

The entire roadway along the coast from the Pali to Lahaina needs to be rerouted Mauka before it falls into the ocean. Then the area between the road and the ocean can then be returned back to public use. So much of this roadway is in danger to falling in the ocean and during high surf being a danger to motorist.

There was a beautiful area to picnic and BBQ at the entrance to Olowalu. The water was always crystal clear and the circular inner reef created almost a lagoon like setting for the kids to swim. It was about 50 yards before the drainage outlet coming into Olowalu. The reef is still there but not as
vibrant anymore. But, the beach area is gone. Like many areas of the coast it has been swallowed up by the ocean. The kiawe trees that once created shade for our picnics now lie in the ocean. The ocean is now up to the roadway and like many of the picnic areas along that route it has given way to high tides that splash onto the roadway.

It's time to recreate that beauty of old. The road needs to be moved Mauka allowing for space again for families to enjoy the beachfront. This plan encompasses that restoration of shoreline. It's time to bring Maui people back to the area and restore the town culture that has disappeared not just in Olowalu but on the entire West side.

This plan shows that the developers care about Maui. This plan gives the locals an opportunity to be a part of a beautifully planned community. Everything else along the coast is owned by the rich. Give the locals a chance to be a part of the area and recreate beautifully planned community.

Thank you for this opportunity to submit testimony.

Sincerely,

Stephen E Smith (DePonte and Aikau Ohana)

Sent from my iPad
To: The State of Hawaii Land Use Commission

Concerning: A10-786 Olowalu Town Testimony on the Final-Environmental Impact Statement

Dear State of Hawaii Land Use Commission,

For the reasons presented in this testimony, please consider the rejection of the Final-Environmental Impact Statement (FEIS) for the proposed development of Olowalu Town on the island of Maui.

The coral reef community (or benthic composition) is under represented:
The benthic composition maps provided by the FEIS are created from models; they are not created from actual data. The area of Olowalu’s coral reef that the FEIS attempts to address is approximately 454 acres or ~1.8 million square meters. The area that the FEIS actually covered in the field by the five, 500 meter long transects (and assuming 1 meter wide) is roughly 2500 square meters, or 0.62 acres. Another way to express the FEIS data is that each of their 200 “calibration/validation” sites covered 3.33m² or 4 pixels of remote sensing imagery, providing only 800 pixels of actual data. The number of pixels in the map is not provided, but it is likely much higher than 800. Clearly the area of coral reef actually covered is not sufficient. Furthermore, it is absolutely not possible for this FEIS to serve as a “baseline” for Olowalu’s coral reef community prior to the development of Olowalu Town due to the complete lack of actual benthic composition data. Since the benthic composition is poorly represented and the current “ground-truthing” data can not serve as a baseline data set, any benthic surveys conducted after Olowalu Town is developed will have little benthic data for comparison to what existed prior to the developmental process. I recommend that the FEIS establishes more transects to provide more actual benthic composition to serve as a baseline data set for Olowalu’s coral reef. It is crucial for the current status of Olowalu’s coral reef to be represented accurately and appropriately with real data.

The marine water chemistry is under represented:
The number of marine water samples collected for water chemistry analyses is not sufficient enough to represent accurate values. Marine water chemistry can be highly variable, and it is a scientific standard for the average of three samples per location to be presented with the associated variance as the result. The FEIS only has one sample per location, and only 60 samples total to address the entire 454 acres of Olowalu’s coral reef. That is equivalent to 1 sample per 7.5 acres. In addition, Transect 1 has extremely high nitrogen levels at the nearshore sites, the reasoning for which was not addressed by the FEIS. In this same area, the Olowalu Landfill was closed in the early 1990’s, and the leachate from this closed landfill might be affecting the nearshore waters. The FEIS failed to even mention the existence of the landfill, and definitely ignored the potential affects of the landfill on the adjacent coastal environment. I recommend that more
marine water samples are collected across the coral reef at Olowalu on the additional transects mentioned above, to represent the water chemistry of the area appropriately. The existing information provides very little information on the current water chemistry.

**The current assessment of shoreline groundwater properties is entirely lacking:**
A number of times the FEIS refers to the emergence of “groundwater at the shoreline” because of a decreasing salinity trend and some elevated nitrogen levels in the nearshore waters, but the FEIS failed to provide actual groundwater samples from the shoreline. I recommend that groundwater samples be taken through standard procedures that often involve a pipe or a piezometer being driven into the ground at the shoreline. The pipe or piezometer is connected with tubing to a peristaltic pump, which extracts the groundwater from the benthos into the collection bottle. Water collection methods such as this were not used in the FEIS so there is currently no baseline for groundwater constituents prior to the development of Olowalu Town. At this time, any shoreline groundwater survey conducted after the development of Olowalu Town will have no data to compare the post developmental results to.

**The affects of sedimentation rates and nutrient levels are inaccurately represented:**
On multiple occasions the FEIS concludes that the development of Olowalu Town will decrease sedimentation rates to the adjacent reef through retention basins. Unfortunately, even with a few retention basins, more sediment will be delivered to the adjacent coral reef when the bare ground of the construction sites is exposed to heavy rains. Once Olowalu Town is built, there will be sustained increased levels of nutrients in the adjacent nearshore coastal water through 5 new major sources: (1) wastewater, (2) fertilizers, (3) leakage at the wastewater treatment plant, (4) 4.7 acre excess R1 leach field, and (5) R1 re-use for irrigation (pg. 22). Unfortunately, in severe contrast to the claims of the FEIS (pg 19, 3rd paragraph), the nutrient responsive algae *Hypnea musciformis* (aka: hook weed) and *Ulva lactuca* (aka: sea lettuce) persist excellently in any high-nutrient reef flat environment regardless of circulation rates. Both species have already formed massive coral-degrading blooms in response to land-based nutrient loading in across Maui, including areas of Kihei, North-West Maui, Maalaea, and from Kahului to Hookipa. In fact, *Ulva sp.* is known to form blooms across the world in response to increased nutrients. I have attached one of my peer-reviewed scientific manuscripts as additional information which investigates the prolific growth of *Hypnea musciformis* and *Ulva lactuca* in response to increased nutrients.

In consideration of the abovementioned issues with the current Final-Environmental Impact Statement for Olowalu Town as well as the complete lack of important land-based assessments (appropriate Hawaiian cultural surveys, traffic issues throughout the developmental process, and traffic issues after the development for West Maui residents, etc.) I respectfully request that it is rejected by your authority.

Thank you for your time and vital thoughts on this important matter,
Meghan Dailer, Marine Researcherdailer@hawaii.edu, P.O. Box 10816, Lahaina, HI 96761
MSc University of Hawaii, Manoa; BS Long Island University, Southampton College
Responses of bloom forming and non-bloom forming macroalgae to nutrient enrichment in Hawai‘i, USA

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Phosphorus
Wastewater
Hawai‘i

ABSTRACT

Macroalgal blooms of Ulva lactuca and Hypnea musciformis have been problematic in shallow coastal waters around agricultural and urbanized regions of Maui, Hawai‘i for decades. Observations have highlighted the correspondence between these blooms and elevated nutrient levels from the adjacent land-use, however little evidence exists regarding the effects of nutrient enrichment on the blooming and non-blooming macroalgae in the area. To determine if elevated nutrient levels influence H. musciformis physiology, we conducted a nutrient enrichment (+N, +P, and +N+P) experiment and measured growth, photosynthetic status, and pigment absorbance. Phycobilin pigments were significantly reduced in the no addition and +P treatment and maintained in those with N additions, suggesting that H. musciformis can use phycobilins to store N. We conducted a second, larger experiment with additions of secondarily-treated wastewater effluent on the bloom forming species Acetabularia spicifera, H. musciformis, and U. lactuca and the common non-bloom forming species Dictyota acutiloba. All samples were initially depleted of potential N stores and measured for growth, photosynthetic status, and N uptake rates; H. musciformis and U. lactuca were also assessed for micro nutrient uptake, % tissue N, and δ15N values. Growth rates of D. acutiloba, H. musciformis, and U. lactuca increased with increasing % wastewater effluent addition and concentrations of TN and NO3− and those of the bloom forming species were 2-fold higher. All species increased photosynthetic capacity and saturation irradiance with increasing % wastewater effluent addition and concentrations of TN and NO3−. U. lactuca was the most sensitive to low N conditions, evidenced by declines in light capturing efficiency. All species utilized a substantial amount of N over 24 h. H. musciformis and U. lactuca also (1) utilized micro nutrients: iron, manganese, molybdenum, and zinc, (2) decreased % tissue N in low N conditions, (3) increased % tissue N in response to elevated N conditions, and (4) expressed elevated δ15N values with increasing additions of wastewater effluent. These results demonstrate that in Hawai‘i, the bloom forming species H. musciformis and U. lactuca, have similar physiological responses to decreased and increased nutrient levels.

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1. Introduction

Excess anthropogenic nutrients severely impact coastal ecosystems worldwide with two general ecosystem responses (1) declines in original habitat, including seagrass meadows in estuaries (Twilley et al., 1985; Burkholder et al., 1992; Zaitsev, 1992; Fong et al., 1993; Peckol et al., 1994) and benthic structure and composition on coral reefs (Barnes, 1973; Smith et al., 1981; Walker and Ormond, 1982; Bell, 1992; McCook, 1999; Cole et al., 2004) and (2) increases in macroalgal growth and abundance (Lapointe, 1997; Paelrl, 1997; Valiela et al., 1997; Stimson et al., 2001; Morand and Merceron, 2005; Viorali et al., 2005). Although declines in herbivore populations from over-fishing (Jackson et al., 2001; Pandolfi et al., 2003) or disease outbreaks (Hughes, 1994) would likely contribute to increases in the percent cover of macroalgae, the formation of macroalgal blooms in close proximity to urbanized and agricultural areas worldwide suggests that anthropogenic nutrient loading is the dominant factor allowing for excessive biomass production (Goreau, 1992; Peckol et al., 1994; Pedersen and Borum, 1997; Raven and Taylor, 2003).

Most macroalgal blooms consist of one or two species, suggesting that the blooming species are more responsive to excess nutrients than other macroalgae in the area. Anthropogenic nutrient driven blooms of opportunistic macroalgae in the genus Ulva (Chlorophyta) (referred to as “green tides”) have been well documented in temperate regions of the world (Brittany, France, Briand, 1989; Puget Sound, Washington, USA, Thom and Albright, 1990; Waquoit Bay, Massachusetts, USA, Valiela et al., 1992;...
Venice, Lagoon, Italy, Sfì­so et al., 1993; Ythan Estuary, Scotland, UK, Raffaelli et al., 1998; Tancada Lagoon, Ebro Delta, NE Spain, Menendez and Comin, 2000; Yellow Sea and East China, Hu et al., 2010. In temperate and tropical regions, increased eutrophication has led to biomass accumulations of opportunistic Chlorophyceae with simple morphologies including Ulva (bistromatic lamina and monostromatic hollow cylinders), Codium (unicellular interwoven filaments), Cladophora (branched filament), Chaetomorpha (unbranched filament), and Ulvaria (monostromatic blades) (Fletcher, 1996; Morand and Briand, 1996; Lapointe, 1997; Valiela et al., 1997; Nelson et al., 2003; Lapointe et al., 2005a; Teichberg et al., 2010). Pedersen and Borum (1996) conclude that opportunistic macroalgae have fast growth and high nutrient uptake rates and are, therefore, able to substantially increase their biomass when exposed to excessive nutrient (nitrogen, N and phosphorus, P) levels. This implies that blooms of opportunistic macroalgae will persist in locations where nutrient levels are sustained above the threshold levels of prolific algal growth (on coral reefs for example: dissolved inorganic N = 1.0 μM, soluble reactive P = 0.1 μM, Bell, 1992) until such nutrients are reduced to levels that will not promote high algal growth rates.

To decrease macroalgal biomass in areas of persistent blooms it is crucial to verify the response of these species to nutrient enrichment and determine the source(s) of land-based nutrients in the area. This information can assist management officials in the decision making processes of regulating land-based nutrient loading in areas of macroalgal blooms. Globally, over the past few decades, sources of anthropogenic N have been detected by investigating the isotopic signature of N (15N:/4N, expressed as δ15N; Eq. 4) (Gartner et al., 2002; Costanzo et al., 2005; Lin et al., 2007; Risk et al., 2009; Dailer et al., 2010, 2012). This is possible because different N sources have distinct δ15N signatures. Naturally occurring and fertilizer N generally range from 0 to 4‰ and −4 to 4‰, respectively (Macko and Ostrom, 1994) and sewage derived wastewater N ranges from 11 to 38‰ (Kendall, 1998; Gartner et al., 2002; Savage and Elmgren, 2004) depending on the level and type of wastewater treatment. Elevated δ15N values arise from the denitrification of nitrate and nitrification of ammonia, during which microbial fractionation occurs for the easier to metabolize, lighter isotope (14N) (Heaton, 1986). The volatilization of 14N-ammonia also enriches the sewage N source in 15N relative to 14N (Heaton, 1986). The release of N2 into the atmosphere has prompted some wastewater treatment facilities (including those on the island of Maui, Hawai‘i, S. Parabicolli, pers. comm.) to use a combination of denitrification and nitrification, termed Biological Nitrogen Removal, to reduce N levels of the effluent (Wiesmann, 1994). The wastewater effluent from such facilities likely has highly elevated δ15N values. Macroalgae take up N from their environment with no evidence of N fractionation (Cohen and Fong, 2005), therefore their δ15N values likely represent the integration of all available N sources. Macroalgae growing adjacent to sewage outfalls frequently have enriched δ15N values ranging from 9 to 15‰ (Gartner et al., 2002; Costanzo et al., 2005; Lin et al., 2007). To date, the highest reported macroalgal δ15N value is 50.1‰ from samples of Ulva lactuca grown over warm, freshwater seeps on a nearshore reef at Kahakili on Maui (Dailer et al., 2010). Kahakili is located near the Lahaina Wastewater Reclamation Facility (operated by the County of Maui) that utilizes Class V injection wells to dispose of 3–5 million gallons of wastewater effluent daily. The wastewater effluent from this facility has been continuously detected on this reef through high δ15N values of transplanted and intertidal macroalgae (Dailer et al., 2010, 2012). Increasing populations and substantial agricultural areas across Hawai‘i subject the adjacent estuaries and coral reefs to anthropogenic nutrient loads (Laws, 2003; Stimson et al., 2001; Derse et al., 2007). In the 1970s, the increased abundance and spread of Dictyosphaeria cavernosa was documented in Kaneohe Bay, Oahu as a result of nutrient-rich sewage discharge to the southern region of the bay (Soegiarto, 1973; Banner, 1974; Smith et al., 1981; Pastrock and Bilyard, 1985). The abundance of D. cavernosa decreased after the sewage was diverted to an offshore outfall (Hunter and Evans, 1995). The role of anthropogenic N in the promotion of opportunistic green macroalgal blooms and often co-occurring red macroalgal blooms has been well documented for temperate (Björnsäter and Wheeler, 1990; Valiela et al., 1992; Fong et al., 1993; Pedersen and Borum, 1997; Fong et al., 1998; Menendez and Comin, 2000; Nelson et al., 2003; Fox et al., 2008; Teichberg et al., 2008; Thornber et al., 2008) and tropical (Smith et al., 1981; Lapointe, 1997; Lapointe et al., 2004, 2005a,b; Barile and Lapointe, 2005) regions. Studies have not specifically linked elevated N and/or P levels to blooms consisting of both Ulva lactuca and Hymnea musciformis (Rhodophyta) in Hawai‘i.

Blooms primarily comprised of H. musciformis and U. lactuca are problematic in shallow, coastal waters around urbanized and agricultural regions of Maui and annually cost over 20 million dollars in economic losses (Van Beukering and Cesar, 2004). Another species commonly found in these blooms is Acanthophora spicifera, which is the most widespread and successful alien invasive alga in Hawai‘i (Smith et al., 2002). These macroalgal blooms occur in the following four regions of Maui across the corresponding length of coastline: (1) northwest, ~7.0 km, (2) central-south, ~2.4 km, (3) southwest, ~10.5 km, and (4) central-north, ~11.3 km (blooms in this region occur during summer months and are decimated with large winter swells) (Fig. 1; West Maui Watershed Owners Manual, 1997; MD per. obs.). The co-occurrence of green and red macroalgal blooms suggests that bloom forming species from different algal phyla may respond similarly to increased N and/or P levels even though their pigment composition differs. Typically in low light conditions, red macroalgae assemble dark colored phycobilin pigments phycocyanin (PE) and phycocyanin (PC), which require more N to construct and absorb more light than chlorophyll complexes (Graham and Wilcox, 2000). However, as documented for Gracilaria spp., PC and PE can also be used to store N (Ryther et al., 1981; Lapointe and Duke, 1984; Horrocks et al., 1995). On Maui, blooms of H. musciformis consist of plants that are dark purple in high light conditions, suggesting that phycobilin pigments are likely used for N storage.

To investigate the role of N and P on the growth, photosynthetic properties, and pigment composition of H. musciformis we performed a preliminary nutrient enrichment experiment with the following treatments: no addition, +NH4+, +PO43−, and +NH4+ +PO43− and +NH4+. Based on the results from the preliminary experiment and the detection of wastewater effluent in areas of H. musciformis

![Diagram of Maui waterways and regions affected by macroalgae blooms.](https://example.com/macroalgae_blooms_diagram.png)
and Ulva lactuca blooms on Maui (Dailer et al., 2010), we adjusted our methods and conducted a larger experiment with incremental additions of secondarily-treated wastewater effluent, containing an assortment of micro nutrients and elevated N levels relative to oligotrophic coral reef conditions. These experiments were conducted on the following four species: Dictyota acutiloba (non-bloom forming), and the bloom forming species, Acanthophora spicifera, H. musciformis, and U. lactuca. To determine if these species would physiologically respond similarly to increasing nutrient levels, we exposed samples to a gradient of wastewater effluent and measured their growth rates, photosynthetic properties, and N uptake rates. For H. musciformis and U. lactuca, additional analyses were performed to determine if they (1) also use micro nutrients, (2) decrease % tissue N in low N conditions, (3) increase % tissue N in high N conditions, and (4) would reflect the associated isotopic signatures ($\delta^{15}N$) from the wastewater N source.

2. Materials and methods

2.1. Preliminary experiment: response of Hypnea musciformis to N and P enrichment

Samples of Hypnea musciformis were collected in July 2006 from Kaimana Beach Park in Honolulu, Oahu (an urbanized area with blooms of H. musciformis and Ulva lactuca) and transported to the University of Hawai‘i, Mānoa. Samples (n = 3 per treatment) were blotted with a towel to remove excess water, trimmed to weigh ~0.400 g, and assessed for initial photosynthetic status with Pulse Amplitude Modulated fluorometry (PAM; see Section 2.3) and pigment composition with in vivo absorbance spectra (Shimadzu UV Vis-2101 spectrophotometer with a Shimadzu 150 mm integrating sphere for macroalgal tissues 0.5 cm × 1.0 cm in dimension; Beach et al., 2000). Samples were transported to the Anuenue aquaculture facility (in Honolulu), and randomly placed in 1.0 L glass beakers (n = 1 per beaker) with individual aerators. Beakers were housed in a shaded (maximum light levels of 500 µmol m$^{-2}$ s$^{-1}$ PAR, measured with a 4π quantum LiCor light sensor) open air tank with a running seawater bath to prevent the treatment waters from heating. Samples were subjected to one of four treatments for seven days: no addition, +P (~4.5 µmol PO$_4^{3-}$), +N (~300 µmol NH$_4^{+}$) and +NP (~300 µmol NH$_4^{+}$ and ~4.5 µmol PO$_4^{3-}$). N concentrations were chosen based on levels reported for blooms of H. musciformis and U. lactuca on Maui (277 DIN; Hunt and Rosa, 2009). P concentrations were based on previous saturation experiments (6–12 µ mol PO$_4^{3-}$; Björnsätter and Wheeler, 1990). Treatment waters in each 1.0 L beaker were changed daily to maintain nutrient concentrations. Water samples were collected (n = 3 per treatment) to verify nutrient additions on days 0 and 7. On the seventh day, samples were assessed for final photosynthetic status with PAM fluorometry (see Section 2.3), weighed, transported to the University of Hawai‘i, Mānoa, and analyzed for final pigment composition with in vivo absorbance. Growth data are expressed as specific growth rates (% d$^{-1}$), calculated as follows, with biomass (N) in g and time (t) in days (Lobban and Harrison, 1994):

$$\mu = \frac{100[\ln (N_{\text{final}}/N_{\text{initial}})]}{t}$$

(1)

2.2. Main experiment: responses of Acanthophora spicifera, Dictyota acutiloba, Hypnea musciformis, and Ulva lactuca to a gradient of wastewater effluent

This study was conducted on the following four species during the corresponding month in 2008 at the University of Hawai‘i, Lahaina field station on Maui: Acanthophora spicifera (September), Dictyota acutiloba (October), Hypnea musciformis (June), and Ulva lactuca (July). Prior to experimental trials, all species were acclimated to low N seawater from Olowalu (a rural area that currently has no anthropogenic nutrient sources) (Fig. 1) to deplete potential internal N stores. Algal samples were collected from Waipuilani Beach Park, transported to the Lahaina field station and randomly placed in 1.0 L beakers with individual aerators (n = 1 per beaker) in a shaded (maximum light levels ca 500 µ mol m$^{-2}$ s$^{-1}$ PAR, measured with a 4π quantum LiCor light sensor) outdoor aquarium system in water baths to prevent the seawater from heating. Low N acclimation occurred for seven days (Fong et al., 1994), during which the seawater in each beaker was changed every two days.

Low N acclimated samples were assessed for initial photosynthetic status with Pulse Amplitude Modulated fluorometry (PAM; see Section 2.3), blotted with a towel to remove excess water, trimmed to weigh ~0.400 g, and assessed to one of the following seven treatments (n = 6 per treatment): (1) no addition and wastewater effluent additions of (2) 25 ml (2.5%), (3) 50 ml (5.0%), (4) 75 ml (7.5%), (5) 100 ml (10.0%), (6) 150 ml (15.0%), and (7) 200 ml (20.0%) to create a final volume of 1.0 L. Each sample was housed in a 1.0 L beaker provided with an aerator in the abovementioned Lahaina field station aquaculture system. The wastewater effluent was a clear liquid obtained at the beginning of each trial from the Lahaina Wastewater Reclamation Facility where it was secondarily treated and disinfected with chlorine. All treatment waters were changed daily with (1) low N water from Olowalu, (2) the corresponding addition of wastewater effluent, and (3) the appropriate addition of natural sea salt to maintain a constant and representative salinity (35‰; confirmed with a 7-Multi conductivity meter model 8603, Mettler-Toledo, Switzerland, calibrated with Mettlert-Toledo conductivity standards). Based on the observations of Naldi and Wheeler (2002) that U. fenestra and Gracilaria pacifica had the highest growth response to increased nutrients over the first nine days and the preliminary observations of H. musciformis in low N conditions for seven days; we elected to run trials for nine days in an attempt to observe a physiologically complete response of the algae to the nutrient gradient. On the ninth day, samples were assessed for final photosynthetic status with PAM fluorometry (see Section 2.3) weighed, and photographed. All growth data are expressed as specific growth rates (% d$^{-1}$) (Eq. (1)).

2.3. Photosynthetic measurements

Samples were assessed for photosynthetic status with Pulse Amplitude Modulated (PAM) fluorometry (Diving PAM, Walz), which measures in vivo chlorophyll fluorescence. Measurements occurred between 1100 h and 1500 h to minimize variation associated with diurnal changes of photosynthetic activity. Rapid Light Curves (RLCs) were used to determine the following photosynthetic parameters (1) relative maximum Electron Transport Rate (rETR$_\text{max}$: maximum photosynthetic capacity), (2) α, the slope of the light limited region of the curve (proportional to the efficiency of light capture), and (3) minimum photosynthetic saturation irradiance (E$_s$: optimal irradiance for maximal electron transport), which is determined by finding the interception of α with the maximum photosynthetic rate (E$_s$ = RTR$_\text{max}$/α) (Ralph and Gademann, 2005). PAM was used to assess samples while connected to a laptop to provide instantaneous observations of the RLCs. The actinic light factor was adjusted to the photosynthetic capacity of the sample to obtain RLCs prior to photoinhibition. All photosynthetic parameters were calculated with the methods provided by Platt et al. (1980), which resulted in reliable parameter estimates (<0.5% variation attributable to error).
2.4. Nutrient concentrations and uptake rates

Nutrient uptake rates were determined over a 24 h period from day eight to nine to obtain rates that would be applicable to ongoing blooms of Hypnea musciformis and Ulva lactuca. For all species, uptake rates were determined for total organic carbon (TOC), total nitrogen (TN), nitrate (NO$_3^-$), and nitrite (NO$_2^-$). For H. musciformis and U. lactuca additional uptake rates were determined for total phosphorus (TP), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn). On days eight and nine, algal samples (n = 3 per treatment) were weighed and corresponding water samples were collected with sterile syringes (prior to the return of the algal sample on day eight), filtered through sterile 0.45 µm nylon filters into acid washed bottles and frozen. Frozen water samples were sent to the Analytical Laboratory, University of Hawai‘i, Hilo and analyzed with the following instrumentation for the corresponding nutrients: Nutrient AutoAnalyzer, NO$_3^-$ and NO$_2^-$ (Martí and Hale, 1981); Shimadzu TOC/TN, TOC and TN; Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES), TP, Cu, Fe, Mn, Mo, and Zn (Garbarino et al., 1989). TP was measured instead of soluble reactive P because it is applicable to the State of Hawai‘i water quality standards. All quality assurance indicators were acceptable (standard curves, lab spikes, certified reference materials, and digestion spikes). Nutrient uptake rates (g$^{-1}$ d$^{-1}$) and % change in the nutrient concentrations were calculated as:

\[
\text{uptake of nutrient } X = \frac{(X_{D9} - X_{D8})}{t} / (N_{D9} - N_{D8}) \tag{2}
\]

\[
\% \text{ change nutrient } X = \frac{X_{D9} - X_{D8}}{X_{D8}} \times 100 \tag{3}
\]

where $X_{D8}$ = concentration of nutrient X on day eight; $X_{D9}$ = concentration of nutrient X on day nine; $N_{D9}$ = biomass of the algal sample on day nine; $t$ = 1 day.

2.5. % tissue N and δ$^{15}$N values of Hypnea musciformis and Ulva lactuca

Samples of Hypnea musciformis and Ulva lactuca (n = 3 per species per condition/treatment) were prepared for the analysis of % tissue N and δ$^{15}$N on the day of field collection (initial bloom levels), the first day of the experimental trials (low N acclimated) and on the ninth day of exposure to wastewater effluent additions. Samples were dried at 60°C to a constant weight, ground with mortar and pestle into a powder, and sent for mass spectrometer analysis of % tissue N and δ$^{15}$N to the Biogeochemical Stable Isotope Laboratory, University of Hawai‘i, Mānoa. Samples were weighed then analyzed with a Carlo Erba NC 2500 Elemental Analyzer, Finnigan MAT ConFloII, and Finnigan MAT DeltaS (with source upgrade). Ratios of δ$^{15}$N:15N were expressed relative to atmospheric N and calculated as (Peterson and Fry, 1987):

\[
\delta^{15}N(\%o) = \left( \frac{R_{\text{sample}}}{R_{\text{standard}}} - 1 \right) \times 10^3, \quad \text{where } R = \frac{^{15}N}{^{14}N} \tag{4}
\]

2.6. Statistical analyses

Preliminary experiment: T-tests were used to determine if there were significant differences in nutrient concentrations between the no addition and enrichment treatments. All data were normally distributed and displayed homogeneity of variances. Growth rates (% d$^{-1}$) were analyzed with a one-way ANOVA. A two-way ANOVA with treatment and day as predictive factors was performed on the initial and final values of $rETR_{\text{max}}$, $E_s$, PC, and PE. If a significant result was obtained for the two-way ANOVA, a Tukey’s post hoc multiple comparisons test was performed to assess differences in final values for each variable between treatments.

Main experiment: All data were normally distributed and displayed homogeneity of variances. Data were examined with regressions (simple, power, and hyperbolic where appropriate) with % wastewater effluent addition and concentrations of total nitrogen (TN) and nitrate (NO$_3^-$) as predictor variables. TN and NO$_3^-$ concentrations were selected from the other nutrients because they increased the most with increasing wastewater effluent addition for all trials and provide information that is applicable to management officials. The following dependent variables were regressed with % wastewater effluent addition and concentrations of TN and NO$_3^-$: (1) growth rate (% d$^{-1}$), $rETR_{\text{max}}$, $E_s$, and $\alpha$ for all species, and (2) % tissue N and δ$^{15}$N values of Hypnea musciformis and Ulva lactuca. T-tests were used to determine significant differences in: (1) initial and final $\alpha$ values of U. lactuca in the no addition, (2) day nine wet weights between the no addition and wastewater effluent additions, (3) day eight water chemistry and nutrient uptake rates between the no addition and additions of wastewater effluent, and (4) % tissue N and δ$^{15}$N values between field and low N acclimated samples of H. musciformis and U. lactuca. Statistics were performed with Statistica 6.0 and SigmaPlot 9.0.

3. Results

3.1. Preliminary experiment: response of Hypnea musciformis to N and P enrichment

The nutrient additions significantly increased the concentration of the nutrient provided compared to the no addition (NA) (Table 1). Significant effects (ANOVA, F = 8.46, P = 0.007) were found between growth rate and nutrient treatment. Growth rates (% d$^{-1}$) in the P treatment were significantly lower than those in the +N and +N+P treatments. NA growth rates were statistically similar to all nutrient treatments (Table 1). A significant interaction (two-way ANOVA, F = 6.52, P < 0.00001) was found with day by treatment. Significant increases in $E_s$ occurred in all treatments (Table 1), the highest $E_s$ values (193 ± 2.8) were

<table>
<thead>
<tr>
<th>No Addition</th>
<th>+P</th>
<th>+N</th>
<th>+N+P</th>
</tr>
</thead>
</table>
| NH$_4^+$ (µM) | 0.48 ± 0.22 | 0.53 ± 0.12 | 325 ± 34.2 | 300 ± 30.5
| PO$_4$ (µM) | 0.07 ± 0.02 | 4.6 ± 0.2 | 0.12 ± 0.03 | 4.6 ± 0.1
| GR (% d$^{-1}$) | 9.51 ± 0.4 | 8.28 ± 0.2 | 11.0 ± 0.2 | 11.2 ± 0.3
| $ETR_{\text{max}}$ | 27.5 ± 2.0 | 28.5 ± 4.3 | 30.6 ± 2.6 | 26.7 ± 0.5
| Initial | 45.0 ± 0.7 | 46.1 ± 1.9 | 39.7 ± 0.6 | 52.6 ± 0.8
| $E_s$ | 0.40 ± 0.02 | 0.38 ± 0.03 | 0.40 ± 0.01 | 0.44 ± 0.02
| Initial | 0.34 ± 0.01 | 0.33 ± 0.01 | 0.30 ± 0.02 | 0.27 ± 0.01
| Initial | 68.3 ± 3.6 | 73.4 ± 7.4 | 77.2 ± 7.7 | 62.0 ± 2.2
| Final | 132 ± 5.6 | 139 ± 4.0 | 133 ± 6.3 | 193 ± 2.8
| PE | 0.98 ± 0.01 | 0.97 ± 0.03 | 0.96 ± 0.03 | 0.98 ± 0.01
| Initial | 0.69 ± 0.03 | 0.77 ± 0.02 | 0.99 ± 0.01 | 1.0 ± 0.02
| Final | 0.78 ± 0.01 | 0.77 ± 0.01 | 0.77 ± 0.01 | 0.80 ± 0.01
| Final | 0.58 ± 0.01 | 0.63 ± 0.01 | 0.79 ± 0.004 | 0.82 ± 0.004

$P < 0.005$.  
$P < 0.005$.  
$P < 0.005$.
observed in the +N+P treatment and were significantly higher than all other treatments (Table 1). Samples in the +N+P treatment also had the only significant increase in rETR$_{\text{max}}$ (Table 1). Final in vivo absorbance spectra showed that samples in the NA and +P treatments had decreased absorbance levels in the spectra range for phycocyanin (PC, 563 nm) and phycoerythrin (PE, 680 nm) (Fig. 2). Final values of PE and PC absorbance normalized to chlorophyll a (680 nm) were significantly decreased from initial values in the NA and +P treatments (Table 1). These values were also significantly lower than those of samples provided with N additions, where no change in PE or PC absorbance occurred (Fig. 2, Table 1).

### 3.2. Main experiment: response of *Acanthophora spicifera, Dictyota acutiloba, Hypnea musciformis, and Ulva lactuca to a gradient of wastewater effluent*

#### 3.2.1. Visual and growth response

In nine days, samples of *Acanthophora spicifera, Dictyota acutiloba, Hypnea musciformis, and Ulva lactuca* visibly responded to the gradient of wastewater effluent (and associated increasing concentrations of TN and NO$_3^-$) with darkened coloration, while no change was observed in the no addition (Fig. 3). No significant relationship was found between the growth rates (% d$^{-1}$) of *A. spicifera* and increasing % wastewater effluent addition (Fig. 4) or TN concentration (Table 2); however a weak but significant relationship was found with increasing NO$_3^-$ concentration (Table 2). Significant relationships were found between the growth rates of *D. acutiloba, H. musciformis, and U. lactuca* and increasing % wastewater effluent addition (Fig. 4) and concentrations of TN and NO$_3^-$ (Table 2). The highest growth rates observed were those of *H. musciformis* (15.8 ± 0.37% d$^{-1}$) and *U. lactuca* (15.5 ± 0.34% d$^{-1}$) in wastewater effluent additions of 20.0% and 10.0%, respectively. These growth rates were about 2-fold higher than the highest rates observed of *A. spicifera* (6.60 ± 0.40% d$^{-1}$) and *D. acutiloba* (7.41 ± 0.11% d$^{-1}$), which occurred in wastewater effluent additions of 7.5% and 20.0%, respectively. The lowest growth rates of *H. musciformis* (3.89 ± 0.16% d$^{-1}$) and *U. lactuca* (4.28 ± 0.20% d$^{-1}$) occurred in the no addition. The growth rate of *H. musciformis* depleted of N stores then placed in the no addition was nearly 3-fold lower than that of the no addition in the preliminary experiment (9.50 ± 0.41% d$^{-1}$) and 5-fold lower than treatments with ≥10.0% wastewater effluent (~15% d$^{-1}$).

#### 3.2.2. Photosynthetic response

The final rETR$_{\text{max}}$ values of all species significantly increased with increasing % wastewater effluent addition (Fig. 5a–d) and concentrations of TN and NO$_3^-$ (Table 2). The highest observed rETR$_{\text{max}}$ values were those of *Acanthophora spicifera* (67.8 ± 4.67) and *Ulva lactuca* (90.8 ± 3.32) in wastewater effluent additions of 15.0% and 20.0%, respectively. No significant relationships were found between the final $a$ values of *A. spicifera, Dictyota acutiloba, and Hypnea musciformis* and increasing % wastewater effluent addition (Fig. 5e–g) and concentrations of TN and NO$_3^-$ (Table 2). Significant relationships were found between the final $a$ values of *U. lactuca* with increasing % wastewater effluent addition (Fig. 5h) and concentrations of TN and NO$_3^-$ (Table 2). These significant relationships were primarily due to a significant decline in $a$ (initial: 0.274 ± 0.006, final: 0.172 ± 0.013, $P < 0.01$) in the no addition. Significant relationships were found between the final minimum photosynthetic saturation irradiance ($E_{\text{sat}}$) values of *A. spicifera, D. acutiloba*, and *H. musciformis* and increasing % wastewater effluent addition (Fig. 5i–k) and concentrations of TN and NO$_3^-$ (Table 2). The highest final $E_{\text{sat}}$ values observed were those of *U. lactuca* in the highest addition of wastewater effluent (346 ± 22.1) and in the no addition (322 ± 19.8) (Fig. 5l). However, the high final $E_{\text{sat}}$ values of *U. lactuca* in the no addition were the product of the decline in $a$ rather than an
increase in minimum photosynthetic saturation irradiance from initial values, $E_k$ is calculated by dividing rETR$_{\text{max}}$ by $\alpha$ and samples in the no addition on day 9 had unchanged rETR$_{\text{max}}$ values (initial: $53.2 \pm 3.09$, final: $54.7 \pm 2.89$); therefore the decline in $\alpha$ consequently produced misleading, higher $E_k$ values. However, this was the only situation where the calculation of $E_k$ was misleading; therefore, we support the view that using RLCs to assess the photosynthetic status of samples is a successful, robust method.
3.2.3. Nutrient concentrations, final wet weights, and uptake rates

In all trials, significant increases in N concentrations of day 8 water samples occurred with increasing additions of wastewater effluent for total nitrogen (TN), nitrate (NO$_3^-$), and nitrite (NO$_2^-$; with the exception of the Acanthophora spicifera trial, where NO$_2^-$ was not detected) (Tables 3–5). The day 8 water chemistry for the Hypnea musciformis and Ulva lactuca trials also had significant increases in concentrations of total phosphorous (TP)
(H. musciformis trial only), iron (Fe), and manganese (Mn) with increasing additions of wastewater effluent (Tables 4 and 5). No significant difference was found between the no addition and additions of wastewater effluent in day 8 nutrient concentrations of copper (Cu), molybdenum (Mo), and zinc (Zn) (Tables 4 and 5). In the U. lactuca trial, TP was only detected in the two highest treatments, Cu was detected in 4 treatments, and Mo and Zn were not detected in any treatment (Table 5).

Significant differences in final wet weights of Acanthophora spicifera and Dictyota acutiloba were found between the no addition and wastewater effluent additions of 2.5–10.0% and 5.0–20.0%, respectively (Table 3). Significant differences were found in the final wet weights of Hypnea musciformis and Ulva lactuca between the no addition and all wastewater effluent additions (Tables 4 and 5). Furthermore, the final wet weights of H. musciformis and U. lactuca in the no addition (0.56 ± 0.03 and 0.56 ± 0.01, respectively) were 2-fold lower than those provided with the lowest wastewater effluent addition of 2.5% (1.19 ± 0.05 and 1.10 ± 0.03, respectively) (Tables 4 and 5). The highest final wet weights of A. spicifera (0.85 ± 0.08), D. acutiloba (0.78 ± 0.03), H. musciformis (1.73 ± 0.07),

Fig. 5. Final photosynthetic parameters rETRmax (a–d), α (e–h) and Ek (i–l) for Acanthophora spicifera, Dictyota acutiloba, Hypnea musciformis, and Ulva lactuca in response to increasing wastewater effluent addition (%); dashed lines represent average initial values.
Table 3
Final wet weight (ww), day 8 nutrient concentrations, nutrient uptake rates (g⁻¹·d⁻¹) (means ± SE), and % change in nutrient concentration from day 8 to 9 per treatment for Acanthophora spicifera and Dictyota acutiloba. Significant differences between the no addition and wastewater effluent additions are in bold, n.d. = not detected.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Treatment</th>
<th>No addition</th>
<th>2.5%</th>
<th>5.0%</th>
<th>7.5%</th>
<th>10.0%</th>
<th>15.0%</th>
<th>20.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Day 8 (µM)</td>
<td>12.8 ± 1.1</td>
<td>99.5 ± 6.9</td>
<td>90.8 ± 2.6</td>
<td>112 ± 7.6</td>
<td>190 ± 41</td>
<td>126 ± 3.7</td>
<td>157 ± 2.7</td>
</tr>
<tr>
<td>% Change</td>
<td>–6.67</td>
<td>–24.2</td>
<td>–20.8</td>
<td>–33.4</td>
<td>–0.24</td>
<td>–24.1</td>
<td>–11.3</td>
<td></td>
</tr>
<tr>
<td>Nitrate (NO₃⁻)</td>
<td>Day 8 (µM)</td>
<td>8.6 ± 0.2</td>
<td>12.8 ± 0.5</td>
<td>17.1 ± 0.5</td>
<td>24.8 ± 0.9</td>
<td>30.3 ± 1.8</td>
<td>45.4 ± 1.1</td>
<td>57.3 ± 0.8</td>
</tr>
<tr>
<td>TN uptake (µM·g⁻¹·d⁻¹)</td>
<td>–2.2 ± 1.2</td>
<td>2.3 ± 0.8</td>
<td>7.9 ± 0.5</td>
<td>4.8 ± 2.5</td>
<td>15.5 ± 0.3</td>
<td>36.9 ± 2.4</td>
<td>32.5 ± 1.7</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>–13.0</td>
<td>13.9</td>
<td>32.1</td>
<td>15.3</td>
<td>44.7</td>
<td>51.1</td>
<td>43.6</td>
<td></td>
</tr>
<tr>
<td>NO₃⁻ uptake (µM·g⁻¹·d⁻¹)</td>
<td>0.21 ± 0.07</td>
<td>5.6 ± 0.1</td>
<td>14.7 ± 0.4</td>
<td>19.1 ± 0.4</td>
<td>20.8 ± 1.1</td>
<td>42.4 ± 3.9</td>
<td>31.8 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>57.8</td>
<td>94.3</td>
<td>98.7</td>
<td>98.7</td>
<td>98.9</td>
<td>81.6</td>
<td>59.4</td>
<td></td>
</tr>
</tbody>
</table>

and U. lactuca (1.40 ± 0.11) were observed in treatments of 10.0–20.0% (Tables 3–5).

TN uptake rates of Acanthophora spicifera, Hypnea musciformis, and Ulva lactuca in treatments ≥5.0% wastewater effluent were significantly increased from those of the no addition (Tables 3–5). The highest TN uptake rates (µmol TN·g⁻¹·d⁻¹) of A. spicifera (36.9 ± 2.40), Dictyota acutiloba (58.9 ± 1.56), H. musciformis (28.1 ± 3.84), and U. lactuca (31.4 ± 3.44) were observed in wastewater effluent additions of 15.0–20.0% (Tables 3–5). The % change in TN for all species was lower than 100%. NO₃⁻ uptake rates of all species in treatments ≥2.5% wastewater effluent were significantly increased from those of the no addition and U. lactuca removed 100% of NO₃⁻ in all treatments (Tables 3–5). The highest NO₃⁻ uptake rates (µmol NO₃⁻·g⁻¹·d⁻¹) of A. spicifera (42.4 ± 3.90), D. acutiloba (50.6 ± 0.91), H. musciformis (24.9 ± 2.81), and U. lactuca (28.5 ± 0.21) occurred in wastewater effluent addition of 15.0–20.0% (Tables 3–5). H. musciformis removed 100% of TP, Fe, Mo, and Zn in all treatments (with the exception of Fe in the 10.0% wastewater effluent addition and Mo in the no addition) (Table 4). The highest Mn uptake rates of H. musciformis (5.79 ± 0.93 ppb·g⁻¹·d⁻¹) and U. lactuca (2.32 ± 0.73 ppb·g⁻¹·d⁻¹) occurred in wastewater effluent addition of 20.0% and 7.5%, respectively (Tables 4 and 5). Mn uptake rates of H. musciformis in wastewater effluent additions of 7.5, 10.0, and 20.0% were significantly higher than those of the no addition (Table 4). For all species, in all treatments, the total organic carbon concentrations of the incubation water generally increased from day 8 to 9 (Tables 3–5).

3.2.4. % tissue N and δ¹⁵N values of Hypnea musciformis and Ulva lactuca
The low N acclimated % tissue N of Hypnea musciformis (1.02 ± 0.03) and Ulva lactuca (1.14 ± 0.29) were significantly (P < 0.0001) decreased from bloom levels (2.81 ± 0.70 and 3.31 ± 0.31, respectively). The final % tissue N of H. musciformis and U. lactuca significantly increased with increasing % wastewater effluent addition (Fig. 6) and concentrations of TN and NO₃⁻ (Table 2). The δ¹⁵N values of H. musciformis and U. lactuca after low N acclimation and in the no addition were not significantly changed from initial bloom levels. The final δ¹⁵N values of H. musciformis and U. lactuca significantly increased with increasing % wastewater effluent addition (Fig. 6) and concentrations of TN and NO₃⁻ (Table 2). The highest δ¹⁵N values observed were those of U. lactuca (30.3 ± 0.3 %) in the highest wastewater effluent addition.

4. Discussion
Opportunistic macroalgae in the genus Ulva are known to form blooms in response to excess anthropogenic nutrients worldwide (Briand, 1989; Thom and Albright, 1990; Srifo et al., 1993; Raffaelli et al., 1998; Menendez and Conin, 2000; Hu et al., 2010). Blooms of Hypnea musciformis have been documented in nutrient enriched areas of Florida (Avery, 1997; Lapointe and Bedford, 2007), but nutrient driven blooms consisting of both H. musciformis and U. lactuca have not been documented. This study shows that H. musciformis is an opportunistic macroalga capable of physiologically responding to excess nutrients at rates equal to the world renowned Ulva spp. in nearshore regions of Maui that are affected by anthropogenic nutrient enrichment.

4.1. N storage of Hypnea musciformis
The preliminary N and P experiment on H. musciformis confirmed that this species responds to high N conditions by
Table 4
Final wet weight (ww), day 8 nutrient concentrations, nutrient uptake rates (g–1 d–1) (means ± SE), and % change in nutrient concentrations from day 8 to 9 per treatment for *Hypnea musciformis*. Significant differences between the no addition and wastewater effluent additions are in bold, n.d. = not detected.

<table>
<thead>
<tr>
<th>No addition</th>
<th>2.5%</th>
<th>5.0%</th>
<th>7.5%</th>
<th>10.0%</th>
<th>15.0%</th>
<th>20.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final ww (g)</td>
<td>0.56 ± 0.03</td>
<td><strong>1.19 ± 0.05</strong></td>
<td><strong>1.41 ± 0.08</strong></td>
<td><strong>1.38 ± 0.07</strong></td>
<td><strong>1.73 ± 0.07</strong></td>
<td><strong>1.54 ± 0.08</strong></td>
</tr>
<tr>
<td>Total organic carbon (TOC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (μM)</td>
<td>69.8 ± 4.7</td>
<td>77.1 ± 1.2</td>
<td>73.8 ± 4.4</td>
<td>88.6 ± 3.6</td>
<td><strong>103 ± 1.0</strong></td>
<td>104 ± 21</td>
</tr>
<tr>
<td>% Change</td>
<td>–37.5</td>
<td>–21.6</td>
<td>–49.6</td>
<td>–36.8</td>
<td>–12.6</td>
<td>–28.7</td>
</tr>
<tr>
<td>Total nitrogen (TN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (μM)</td>
<td>5.9 ± 0.1</td>
<td><strong>17.0 ± 0.6</strong></td>
<td><strong>29.3 ± 2.8</strong></td>
<td><strong>39.8 ± 2.3</strong></td>
<td><strong>54.7 ± 2.0</strong></td>
<td><strong>67.7 ± 17</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>25.6</td>
<td>65.0</td>
<td>73.4</td>
<td>79.6</td>
<td>85.2</td>
<td>62.0</td>
</tr>
<tr>
<td>Nitrate (NO3–)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (μM)</td>
<td>0.19 ± 0.08</td>
<td><strong>5.4 ± 0.3</strong></td>
<td><strong>9.1 ± 1.2</strong></td>
<td><strong>16.0 ± 1.0</strong></td>
<td><strong>22.0 ± 1.0</strong></td>
<td><strong>28.1 ± 7.2</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>21.5</td>
<td>93.4</td>
<td>93.6</td>
<td>98.3</td>
<td>95.7</td>
<td>89.6</td>
</tr>
<tr>
<td>Nitrite (NO2–)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (μM)</td>
<td>n.d.</td>
<td><strong>7.2 ± 0.1</strong></td>
<td><strong>12.6 ± 0.7</strong></td>
<td><strong>19.6 ± 0.6</strong></td>
<td><strong>31.0 ± 1.3</strong></td>
<td><strong>40.8 ± 14</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>–</td>
<td>100</td>
<td>99.7</td>
<td>98.3</td>
<td>94.7</td>
<td>43.4</td>
</tr>
<tr>
<td>Ammonium (NH4+)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (μM)</td>
<td>n.d.</td>
<td><strong>0.9 ± 0.2</strong></td>
<td><strong>1.6 ± 0.3</strong></td>
<td><strong>2.8 ± 0.4</strong></td>
<td><strong>5.9 ± 0.1</strong></td>
<td><strong>8.1 ± 0.5</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>–</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Total phosphorous (TP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (μM)</td>
<td>0.29 ± 0.06</td>
<td><strong>0.52 ± 0.06</strong></td>
<td><strong>0.81 ± 0.04</strong></td>
<td><strong>1.0 ± 0.1</strong></td>
<td><strong>1.7 ± 0.04</strong></td>
<td><strong>2.1 ± 0.03</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (ppb)</td>
<td>0.99</td>
<td>2.2 ± 0.2</td>
<td>2.1 ± 0.2</td>
<td>1.86</td>
<td>1.7 ± 0.6</td>
<td>2.6 ± 1.7</td>
</tr>
<tr>
<td>% Change</td>
<td>–</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Fe uptake (ppb g–1 d–1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (ppb)</td>
<td>0.77</td>
<td>0.45 ± 0.05</td>
<td><strong>0.81 ± 0.03</strong></td>
<td><strong>0.75 ± 0.04</strong></td>
<td><strong>0.95 ± 0.02</strong></td>
<td><strong>1.3 ± 0.1</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>–</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (ppb)</td>
<td>0.39 ± 0.06</td>
<td><strong>3.6 ± 0.5</strong></td>
<td><strong>5.4 ± 0.8</strong></td>
<td><strong>6.6 ± 0.2</strong></td>
<td><strong>12.3 ± 0.2</strong></td>
<td><strong>16.0 ± 3.2</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>100</td>
<td>85.9</td>
<td>73.1</td>
<td>65.2</td>
<td>78.1</td>
<td>23.5</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 8 (ppb)</td>
<td>6.4 ± 0.2</td>
<td><strong>8.9 ± 0.1</strong></td>
<td><strong>7.0 ± 0.5</strong></td>
<td><strong>6.3 ± 0.1</strong></td>
<td><strong>7.2 ± 0.3</strong></td>
<td><strong>5.4 ± 0.3</strong></td>
</tr>
<tr>
<td>% Change</td>
<td>85.7</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

* P < 0.05.
** P < 0.005.
*** P < 0.0005.

4.2. Nutrient effects on growth rates

All species visually responded to increasing additions of wastewater effluent (and increased N supply) with darkened coloration. These observations agree with those of Lapointe et al. (1976), where *Hypnea musciformis* responded to increased wastewater N supplies (140 mg/l) with dark brown, almost black pigmentation. All species also increased growth rates when provided with additional N, however, the bloom forming species, *H. musciformis* and *Ulva lactuca*, were more responsive in terms of building biomass than *Acanthophora spicifera* (another bloom forming species) and *Dictyota acutiloba* (non-bloom forming). Although *A. spicifera* is known to form blooms in Hawai’i (Smith et al., 2002) and responded to increased nutrients with increased growth, it was not as responsive as *H. musciformis* and *U. lactuca*. This may be because of the morphological differences between the species, as *A. spicifera* is polysiphonous, *H. musciformis* is pseudoparenchymatous and *U. lactuca* is dictromatic. *H. musciformis* and *U. lactuca* responded to the increased nutrient levels in the smallest wastewater effluent addition of 2.5% with 2-fold higher biomass than those in the no addition. In addition, the growth rate of *H. musciformis* depleted of N stores and then subjected to the no addition was nearly 3-fold lower than that of the no addition in the preliminary experiment and 5-fold lower than treatments of 10.0% wastewater effluent and above. The maximum growth rates of *H.
musciiformis and U. lactuca in this study were approximately 0.24 g d\(^{-1}\), which is slightly slower than 0.34 g d\(^{-1}\) reported for *U. lactuca* in the Roskilde Fjord (Pedersen and Borum, 1996). However, in the summer months, these northern fjords receive 16 h of sunlight (Pedersen and Borum, 1996) compared to 12 h in Hawai‘i. These results are similar to those of Larned (1998) where samples of *U. lactuca* provided with additions of N and P grew significantly faster than those in the control or P addition, suggesting that *U. lactuca* is N limited in Hawai‘i. The high growth rates of *H. musciiformis* and *U. lactuca* (~15% d\(^{-1}\)) are comparable to those observed for the bloom forming *U. lactuca* in Waquoit Bay from in situ N and P enrichment experiments (over 13 d) (Teichberg et al., 2008). Our findings are also consistent with those of other studies on *Ulua* that report increased growth rates with increased nutrient supplies (Bjørnsæter and Wheeler, 1990; Pedersen and Borum, 1996, 1997; Fox et al., 2008).

### 4.3. Nutrient effects on photosynthetic properties

All bloom forming species tested in this study responded to increased nutrients with increased photosynthetic performance (\(\text{rETR}_{\text{max}}\)) and saturation irradiance (\(E_s\)). These findings are consistent with those of Valiela et al. (1997) where elevated maximum photosynthetic rates were characteristic of bloom forming macroalgae in increased nutrient conditions. These results also agree with those of Pedersen and Borum (1996) who found that out of 12 species tested in laboratory N enrichment experiments, *U. lactuca* had the highest growth rates and suffered the most from N limitation. In this study, *U. lactuca* was the only species to show substantial declines in photosynthetic properties when deprived of nutrients. The photosynthetic efficiency (\(\alpha\)) and % tissue N of *U. lactuca* were significantly decreased after a total of 16 days in low N conditions (seven days of low N acclimation followed by nine days in the no addition). These results (1) support the findings of Rosenberg and Ramus (1982) which conclude that N pools in *Ulva* consist mainly of chlorophyll-protein complexes, (2) agree with those of Henley et al. (1991) (for *U. rotundata* over seven days) that the light capturing efficiency of *U. lactuca* is negatively affected by low N conditions, and (3) verify that chlorophyll–protein complexes are utilized in *U. lactuca* when subjected to low N conditions for extended periods of time.

### 4.4. Nutrient uptake rates and total organic carbon release

All species were able to take up high levels of TN, NO\(_3\)-, and NO\(_2\)- (with the exception of the *A. spicifera* trial where NO\(_2\)- was not detected) and uptake rates increased with increasing wastewater effluent additions. These results are similar to those of other studies where bloom forming macroalgae increased nutrient uptake rates in response to increased nutrient supplies (Peckol et al., 1994; Pedersen and Borum, 1997; Valiela et al., 1997). The % change in TN for all species was lower than 100%, indicating that the samples were not likely N-limited. The TN uptake rates observed in this study are comparable to those

---

**Table 5**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>No addition</th>
<th>2.5%</th>
<th>5.0%</th>
<th>7.5%</th>
<th>10.0%</th>
<th>15.0%</th>
<th>20.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO(_2)-</td>
<td>0.10 ± 0.01</td>
<td>0.19 ± 0.01</td>
<td>0.62 ± 0.01</td>
<td>0.85 ± 0.07</td>
<td>0.98 ± 0.07</td>
<td>1.08 ± 0.14</td>
<td>1.54 ± 0.13</td>
</tr>
<tr>
<td>NO(_3)-</td>
<td>0.17 ± 0.01</td>
<td>0.49 ± 0.01</td>
<td>0.74 ± 0.06</td>
<td>0.82 ± 0.06</td>
<td>0.83 ± 0.10</td>
<td>1.10 ± 0.09</td>
<td>1.10 ± 0.09</td>
</tr>
<tr>
<td>% Change</td>
<td>–26.7</td>
<td>–74.0</td>
<td>21.3</td>
<td>–6.09</td>
<td>–84.7</td>
<td>–83.5</td>
<td>2.98</td>
</tr>
</tbody>
</table>

---

* P < 0.05.
** P < 0.005.
*** P < 0.0005.
reported by Björnsäter and Wheeler (1990) for U. fenestrata under N-enriched and P-limited conditions (27.1 ± 6.9 μmol TN g⁻¹ d⁻¹), which were significantly lower than those in the N and P enriched treatment (133.7 ± 9.3 μmol TN g⁻¹ d⁻¹). Björnsäter and Wheeler (1990) suggested from these findings that algae regulate N and P uptake to maintain a balanced internal N:P ratio, which indicates that the species tested in this study might have higher N uptakes rates when provided with higher P concentrations. H. musciformis and U. lactuca acquired Mn and all available Fe from the surrounding media. H. musciformis also acquired all available P, Mo, and Zn confirming that micro nutrients such as Fe, Mn, Mo, and Zn are vital for growth and photosynthetic properties.

H. musciformis NO₃⁻ uptake might have been affected by limited NO₃⁻ reductase activity because of the presence of NH₄⁺ (Thomas and Harrison, 1985; Young et al., 2005). Another, more likely possibility is that NO₃⁻ uptake was limited by Fe because NO₃ utilization depends on Fe-containing enzymes and requires high cellular Fe quotes (Viaroli et al., 2005). In the highest wastewater effluent addition, all available Fe was utilized but the nitrate was only decreased by 85%. However, Maui soils are derived from intermediate–weathering of basalt and are rich in Fe and other nutrients (Choveror et al., 2004); therefore it is unlikely that the blooms of H. musciformis and U. lactuca are Fe limited.

For all species, in all treatments, the total organic carbon of the incubation water generally increased over 24 h, which is consistent with the observations of Khailov and Burlakava (1989) that macroalgae release large amounts of organic matter. Generally, macroalgae frequently fix carbon in excess of metabolic needs for growth and subsequently release the unused dissolved organic carbon (DOC) (Alber and Valiela, 1994). In bloom situations, this is likely to further alter ecosystem properties as substantial quantities of DOC enter the microbial food web (Alber and Valiela, 1994). Furthermore, Smith et al. (2006) document that the dissolved organic matter released from macroalgae promotes microbial growth and subsequently causes coral mortality. The vast majority of coral disease incidences occur on reefs with moderate to high anthropogenic impacts (Green and Bruckner, 2000). DOC loading caused significant coral mortality and increased (by an order of magnitude) growth rates of microbes associated with coral mucus (Kline et al., 2006), which suggests that these microbial assemblages are carbon limited. These findings in the combination with other studies (Pantos et al., 2003; Sutherland et al., 2004) further indicate that increased levels of DOC in wastewater (and other organic sources) from coastal developments could contribute to the high incidence of coral disease on adjacent reefs. Future work on Maui should therefore include efforts in bloom and non-bloom areas to identify microbial communities in terms of composition and abundance in disturbed and natural states.

4.5. % tissue N and δ¹⁵N values

The % tissue N of Hypnea musciformis and Ulva lactuca decreased from bloom levels when acclimated to low N conditions, then significantly increased with increasing wastewater addition and concentrations of TN and NO₃⁻. These results are similar to those of Lapointe et al. (1976) where H. musciformis increased % tissue N in high N (3.4%; 140 mg/l) compared to low N (2.5%; 49 mg/l) conditions. In agreement with other studies, these findings confirm that both species are opportunistic, because they are capable of rapidly building N stores when exposed to increased N supplies.
5. Summary and conclusions

This study confirms that in elevated N conditions, *Hypnea musciformis* stores N by building dark colored phycobilin pigments. This study also confirms that *H. musciformis* and *Ulva lactuca* are opportunistic macroalgae capable of exploiting elevated nutrient levels to rapidly generate substantial amounts of biomass. It is also apparent from this study that *H. musciformis* and *U. lactuca* blooms on Maui will collapse if their resources are depleted. The nutrient enhanced accelerated growth rates of these blooming species suggests, in agreement with numerous other studies from temperate and tropical regions (Littler et al., 1991, 1993; Hunter and Evans, 1995; Fletcher, 1996; Morand and Briand, 1996; Lapointe, 1997; Valiela et al., 1997; Menendez and Comin, 2000; Nelson et al., 2003; Lapointe et al., 2005a,b; Lapointe and Bedford, 2007, 2010; see DeGeorges et al., 2010 for a review), that these blooms will proliferate where land-based nutrients are improperly disposed of. Therefore the interception of land-based nutrients is likely the most effective way for resource managers to diminish bloom formations on Maui. Improved control of land-based nutrients entering the nearshore marine environment could be achieved in various ways, including, reducing nitrogen levels in the injected wastewater effluent, eliminating cesspools in coastal areas, and managing runoff from massive active and inactive agricultural regions. Even secondarily treated wastewater effluent has levels of nitrogen and phosphorus that can drive macroalgal bloom formation in coastal areas with long residence times (US EPA, 1972; DeGeorges, 1990). Cesspools can potentially leach elevated nutrients and bacteria into the adjacent coastal area (US EPA, 1972). Agricultural practices have been known to enrich coastal regions worldwide, including those on Maui, for decades (Soicher and Peterson, 1997; Goreau, 2003). Regulating these and other land-based nutrient sources will greatly improve the health of the remaining coral reefs on Maui and throughout the Hawaiian islands.

Acknowledgements

This work was funded by the Hawai‘i Coral Reef Initiative grant # MA07NOS4000193. We thank the County of Maui, Division of Environmental Management former Director C. Okuma, S. Parabicioli and staff of the Lahaina Wastewater Reclamation Facility for their cooperation and assistance, C. Bird for experimental design and statistical guidance, and many anonymous reviewers whose comments improved earlier versions of this manuscript.[SS]

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DeGeorges, A., Goreau, T.J., Bentley, J.L., 2010. Land-sourced pollution with an empha-
Fong, P., Boyer, K.E., Zedler, J.B., 1998. Developing an indicator of nutrient enrich-


2,322 signers: #SaveOlowalu: Please Testify To The State Of Hawaii LUC, Reject The Olowalu EIS petition
John Fitzpatrick

to:
State Land Use Commission, Members of the Land Use Commission
12/03/2015 12:25 PM

Dear State Land Use Commission,

I started a petition to you titled #SaveOlowalu: Please Testify To The State Of Hawaii LUC, Reject The Olowalu EIS. So far, the petition has 2,322 total signers.

You can post a response for us to pass along to all petition signers by clicking here:

The petition states:

"On November 18th we need to let the Hawaii State Land Use Commission know that we reject the plan for an Olowalu town development and we reject the Environmental Impact Statement (EIS) that Frampton and Ward are presenting in order to build their 1700-home city at Olowalu. This city will increase the West Maui population by over 4,000 residents and 3,000 more cars on an already overcrowded infrastructure. In addition, marine biologists from around the world have said it will likely kill our largest, oldest and extremely priceless coral reef ecosystem that house 700+ year old coral colonies, endangered monk seals, sea turtles, fish, invertebrates and other endemic species. What's at stake? • Our ocean, reef eco-system (700 year old kupuna coral), limu and fish • Existing roads and traffic are already horrible; imagine 3,000 more cars • Our streams and aquifers • Over-crowded schools • Loss of prime agricultural land • Public access to the coastline • Traditional and customary use of Olowalu lands and waters Please sign the petition and, if possible, show up to testify on Wednesday, Nov. 18, 2015 at 9:30 AM. We only have seven days to get the word out. #saveolowalu facebook event to get instructions.

https://www.facebook.com/events/1517489378544315/"

To download a PDF file of all your constituents who have signed the petition, including their addresses, click this link: http://petitions.moveon.org/deliver_pdf.html?job_id=1679957&target_type=custom&target_id=64216

To download a CSV file of all of your constituents who have signed the petition, including their addresses, click this link: http://petitions.moveon.org/deliver_pdf.html?job_id=1679957&target_type=custom&target_id=64216&csv=1

Thank you.

--John Fitzpatrick
If you have any other questions, please email petitions@moveon.org.

The links to download the petition as a PDF and to respond to all of your constituents will remain available for the next 14 days.

This email was sent through MoveOn's petition website, a free service that allows anyone to set up their own online petition and share it with friends. MoveOn does not endorse the contents of petitions posted on our public petition website. If you don't want to receive further emails updating you on how many people have signed this petition, click here: http://petitions.moveon.org/delivery_unsub.html?e=soBXjUW3mIZGl5GgesCKzSBsdWNAZGJ1ZHQaGF3YWlpLmdvdg--&petition_id=102740.
Dear Land Use Commissioners,

I was born and raised on Maui and I live in Olowalu. And, I deeply love and care about Olowalu. I am writing to provide my support for the approval of the Final Environmental Impact Statement for the Olowalu Town Master Plan; DKT. NO. A10-786. I have reviewed the Final EIS for this project and believe that the document is very thorough.

It is my understanding that a Final Environmental Impact Statement is utilized to disclose potential impacts for a proposed development. The Olowalu Town Final EIS utilizes many professionals in their various fields of expertise to provide information about the impacts of the Olowalu Town Master Plan.

It is not surprising that some members of the community do not agree with everything within the document. In fact, it would be impossible to create a document in which someone would not disagree. However, this Final EIS is a complete disclosure document that is well prepared and thorough. If this document is not acceptable, I fear that the system will not allow for worthy projects to progress through the review system which will be detrimental to Hawaii moving forward.

Olowalu is a special place. I deeply love and care about Olowalu and Maui. For this reason I strongly support the Olowalu Town Master Plan.

Please approve the Olowalu Town Final Environmental Impact Statement.

Sincerely,

Ali Martin
December 2, 2015

Land Use Commission
PO Box 2359
Honolulu, HI 96804
Fax: 808 587-3827
E-mail: luc@dbedt.hawaii.gov

Re: Testimony IN FAVOR of Final Environmental Impact Statement
Olowalu Town Master Plan (DKT. NO. A10-786)

Dear Land Use Commissioners,

I am writing to provide my support for the approval of the Final Environmental Impact Statement for the Olowalu Town Master Plan; DKT. NO. A10-786. I believe the EIS is thorough and utilized many professionals in their various fields of expertise to provide information about the impacts of the project.

The implementation of the Olowalu Town Master Plan will improve ocean access for fishermen, beachgoers, divers, and surfers. The Final EIS addresses existing and future traffic concerns with the relocation of Honoapi‘ilani Highway within the project to a more mauka location. The relocation of the highway will remove the high volume, high speed highway away from the ocean activities which will improve the ocean activities experience. The plan calls for large parks at key recreational areas including the Olowalu surf site on the north side of the project.

By allowing limited housing on the lands makai of the existing Honoapi‘ilani Highway, the plan will establish new large parks and open public space within these existing private lands. These parks makai of the existing highway will provide a direct connection of the Olowalu community to the ocean which will create a wonderful place for Maui’s families to live, work, and play.

It is not surprising that some members of the community do not agree with everything within the document. In fact, it would be impossible to create a document in which someone would not disagree. However, this Final EIS is a complete disclosure document that is well prepared and thorough. If this document is not acceptable, I fear that the system will not allow for worthy projects to progress through the review system which will be detrimental to Hawaii moving forward.

Please approve the Olowalu Town Final Environmental Impact Statement.

Very truly yours,

FERGUS & COMPANY
A Limited Liability Company

[Signature]

Alexander L. Fergus
Manager
Aloha Land Use Committee Members,

My name is Margaret Akana, I am a Native Hawaiian living in West Maui and I am very concerned about the proposed Olowalu Town and after reviewing the Final EIS submitted by the developer, my conclusion is that it is incomplete, inaccurate and flawed.

The many testifiers at your last public hearing raised many valid concerns - I have seen endangered nene at Olowalu, why is there no mitigation plan to address the threat development poses to this Endangered Species which is in fact our State bird.

Traffic Impacts are a major concern of everyone I know that currently lives in West Maui. When Launiupoko was approved and a new traffic light was installed it added half and hour plus to the commute from West Maui to the rest of the island. After 5 years of the EIS process, the traffic analyses are still incomplete, there is no clear timeline when the highway will be relocated and a four lane highway is the primary mitigation offered for the huge increase in traffic in an already congested area (ask most residents of West Maui, almost every weekend traffic is backed up for hours on the way to the West side), also the TIAR refers to a future hotel in all its calculations and the text of the FEIS does not mention this?

As a Native Hawaiian I would like to emphasize the point that our cultural practices can not be confined to a cultural reserve area, many areas in Olowalu are important to our history and cultural use may be restricted but no mention of this is made in the FEIS. The shoreline buffer of 150’ is not enough to protect cultural practices and we are already experiencing erosion and sea level rise, which is also a reason that the wastewater treatment plant is much too close to the shoreline. Hawaiians know the importance of fresh water springs to support limu, fish and coral populations, this is traditional knowledge handed down for generations, the FEIS marine report is thus flawed saying that it is not important. Mauka to makai streamflow is essential to healthy ahupuaa and yet the FEIS sets no restoration goals, doesn't propose amending Instream flow standards and does nothing to address this protected use except to use R1 water for irrigation which may or may not happen.

I'm very concerned that the current cultural site preservation plan has not been implemented, I believe this goes to show the developers commitment to our cultural sites and burial areas, it is a telling foreshadow of worse things to come. The relocated Honoapiilani Highway realignment will place a apps 200' high speed highway just below Puu Kilea a traditional burial ground and between two heiau and there has been no coordination with the Federal/State government or the Army Core of Engineers as the developers were advised to do after filing their draft EIS leading me to believe they have not done their due diligence and do not take their responsibilities serious enough.

PleaseReject FEIS Olowalu Town
margaret Akana
to:
luc@dbedt.hawaii.gov
12/03/2015 11:04 PM
Cc:
"saveolowalu@gmail.com"
hide details
from: margaret Akana <margaret.akana@yahoo.com>
to: "luc@dbedt.hawaii.gov" <luc@dbedt.hawaii.gov>
c: "saveolowalu@gmail.com" <saveolowalu@gmail.com>
please respond to margaret Akana <margaret.akana@yahoo.com>
I am asking you to reject the developers FEIS and listen to our community not those who have financial gain riding on this development or even those employed by the landowner and the developers. Our general plan update states this would be excessive amount of housing for West Maui's projected needs given all the developments that already have entitlements and the distance from infrastructure makes it the opposite of LEED smart location, it actually makes it sprawl with tax payers shouldering the burden of police, fire, medic, school and ocean safety services.

In closing, I'm not saying that this project should not go forward, but in deference to our community that lives here and our many concerns in the glaring gaps and the minimizing of environmental, cultural and traffic concerns by the developer, I'm asking that you reject this version of a Final EIS let them go back and correct the inadequacies, address all the concerns, develop plans for mitigation and they can always come back before your commission with a complete and accurate FEIS. Do not accept this FEIS we have already endured too many flawed EIS just look to the results of Launiupoko majority of the houses in that subdivision are for sale, they are diverting water from Kauaula valley at the expense of lo‘i kalo and especially when the light malfunctions which seems to happen almost every weekend it creates a nightmarish traffic situation for the entire West District, look to the results of Mahana Ridge part of the Kapalua Mauka project district and the report by the same Marine Consultants who stated there would be no negative downstream effects and yet despite their use of best management practices by the project manager (above and beyond what was required) they were unable to keep sediment and green waste on their project sites, the sediment retention basins were inadequate and for the past few years this project has had a significant documented negative impact on downstream nearshore environment. We are not willing to take this chance with Olowalu. Do not accept this FEIS.

Mahalo,
Margaret "Mugs" Akana
Honokowai Villas
Lahaina, HI 96761
808-276-3853
Jennifer and Philip Schettewi  
PO Box 791540  
Paia, HI 96779  

December 2, 2015  

Land Use Commission  
PO Box 2359  
Honolulu, HI 96804  
Fax: 808 587-3827  
E-mail: luc@dbedt.hawaii.gov  

Re: Testimony IN FAVOR of Final Environmental Impact Statement  
Olowalu Town Master Plan (DKT. NO. A10-786)

Dear Land Use Commissioners,

We are writing to provide our support and encouragement for the approval of the Final Environmental Impact Statement for the Olowalu Town Master Plan; DKT. NO. A10-786.

Based on our experience and knowledge of living in Hawaii and after a thorough review of the Olowalu Master Plan, the implementation of the Olowalu Town Master Plan will improve ocean access for fishermen, beachgoers, divers, as well as surfers. The Final EIS addresses existing and future traffic concerns with the relocation of Honoapi'ilani Highway within the project to a more mauka location. The relocation of the highway will remove the high volume, high speed highway away from the ocean activities which will improve the ocean activities experience. The plan calls for large parks at key recreational areas including the Olowalu surf site on the north side of the project.

By allowing limited housing on the lands makai of the existing Honoapi'ilani Highway, the plan will establish new large parks and open public space within these existing private lands that will benefit all. These parks makai of the existing highway will provide a direct connection of the Olowalu community to the ocean which will create a wonderful place for Maui's families to live, work, and play.

As residents of Hawaii, we strongly urge you to approve the Olowalu Town Final Environmental Impact Statement.

Sincerely,

[Signatures]