Problem Statement
Tourism is one of the world’s largest industries, accounting for more than 10% of the global economy. Today, tourism accounts for approximately one-fourth of French Polynesia’s GDP and is a primary source of hard currency earnings. In French Polynesia, mass tourism is a major component of tourist ventures including large hotel and resort developments as well as cruise ship operations. Although mass tourism brings in more tourists and gross revenue than any other tourism scenario, negative impacts can occur when the level of visitor use exceeds the environment’s ability to cope with this use. With its white coral sand beaches, diversity of marine life, and dramatic topography, Moorea is a premier tourist destination. However, increased demands on local services such as water, sewage, solid waste, fuel, power, roads, and medical services could ultimately destroy the very natural resources that attract visitors to Moorea in the first place.

In addition to the typical tourist vacation there is a market for tourism emphasizing ecological and cultural experiences. Much of this type of tourism is termed ecotourism, defined by the International Ecotourism Society as “…responsible travel to natural areas that conserve the environment and sustain the well being of local people”. Ecotourism is appropriate in places where main attractions are ecological, cultural and scenic resources that can be degraded by the impacts of intensive tourism expansion. Today, ecotourism comprises up to 20% of the overall worldwide tourism industry with annual growth rate ranging between 10-30%.

Objectives
As an alternative to typical tourism, we assessed the potential for ecotourism on Moorea to attract international visitors, support local businesses and products, preserve local customs and practices, raise awareness of natural resource issues and finance their protection.

Methods
Using criteria developed by University of California, Berkeley Professor Randy Hester and Mark Hampton of University of Portsmouth, UK, we evaluated the potential for ecotourism on the island of Moorea and suggested means for implementation. Information gathered was organized into five main principles of ecotourism.

Unspoiled Landscape
Ecotourists want an unspoiled natural landscape and insensitive development can have adverse visual impacts. Urbanization should not blemish the dramatically beautiful natural landscape but rather occur in accordance with the environment.
**Unique Character** Ecotourists are interested in experiencing what is distinctive about a place over conventional suburban sprawl development that is not unique. Modernization on Moorea should occur in a way that preserves the unique character of Polynesian architecture.

**Knowledgeable Hosts** Ecotourists appreciate hosts who can provide local information and details about ecology, history, and culture.

**Insider Events** Ecotourists want to experience things that other mass tourists do not get to see. This can include actively participating in habitat restoration, local ecology and culture. Ecotourists can participate in and be part of everyday occurrences and learn first hand what local people do. This includes participating in active duties of local vocations to experience “real work.”

**Recommendations**

**INTEGRATIVE PLANNING SOLUTIONS**

- Link tourism strategies to broader planning initiatives such as the PGA and PGEM.
- Incorporate broad-based community input and public participation.
- Respect carrying capacity through environmental review.
- Provide quality employment opportunities that reflect local knowledge and trade.

**PLANNING IMPLICATIONS**

**Preserve nature and local culture**

- Protect habitat. Currently, the disconnection between the terrestrial zoning plan (PGA) and the marine management plan (PGEM) does not allow for adequate protection of coral reefs. Investment must be placed on coral reef protection to ensure ecotourists will continue to visit.
- Identify environmental and cultural education opportunities

**Unspoiled Landscape**

- Development should limit road construction and encourage pedestrian access.
- If constructing on a hillside, stilt housing should be used over terracing.
- To protect visual access and view sheds, property divisions should be kept vegetated, as specified in Moorea’s previous terrestrial zoning plan (PGA), rather than divided with tall concrete walls.
- Incorporate Best Management Practices (BMPs) during construction and restore landscape after construction.
- Concentrate development in existing urban areas so large tracts of open space remain intact.
- Integrate “green” golf course practices. See section on Moorea Golf Course Development

**Knowledgeable Hosts**

- Local people should be trained to be professional and knowledgeable in this regard. Here local people with local knowledge can obtain well paying professional jobs doing the things they enjoy.
- Development of the Tahitian Cultural Center on the UC Berkeley property offers an excellent opportunity to circulate traditional knowledge.

**Insider Events**

- Identify and inventory local festivals, authentic places, traditional work, and arts and crafts that ecotourists would want to experience.
- Provide job training opportunities to local individuals and management training to local companies so experience can be professional yet unique.

**Unique Character**

- Currently, Moorea’s terrestrial zoning plan (PGA) has design guidelines that encourages island-style development. However, landscaping guidelines using culturally distinctive and native plants can also be incorporated.
- Land-use plans and zoning laws for new development can protect waterfront property and maintain the regional aesthetic of the area.
Problem Statement
Lake Temae, on the northeast corner of the Island of Moorea in French Polynesia, is one of the best remaining representatives of the coastal wetland, an increasingly rare eco-system in the South Pacific. Listed by the United Nations Environmental Programme (UNEP) as a proposed protected area, Lake Temae’s health and vitality are threatened by the construction of a golf course in the wetlands along its northern shore. In addition to severing Lake Temae’s sole outlet to the sea, development of this golf course will also introduce a significant amount of chemicals into this sensitive coastal region, threatening several vulnerable species as well as the local islanders who depend on the ocean and the lake for subsistence.

Objectives
Given the sensitive nature of the development site, more careful study and planning are necessary to re-evaluate whether a golf course in this location is the best decision for Moorea’s future.

Methods
Evaluation of Moorea’s Lake Temae Golf Course Development occurred through literature review, site analysis, comparison with precedent case studies and golf course practices, and review of existing policies and environmental standards.

Results
TEMAE GOLF COURSE, A NICKLAUS DESIGN
Founder and famous golfer Jack Nicklaus states: “I’m proud of the fact that even when we work in countries with less restrictive rules, we voluntarily apply United States rules to all Nicklaus Design work.”

UNDER U.S. STANDARDS, NICKLAUS DESIGN SHOULD:
Comply with Section 404 of the Federal Clean Water Act, which protects wetlands. Through this act developers must demonstrate that there are no feasible alternative upland sites for the project, redesign the course to avoid existing wetlands as much as possible and mitigate for wetlands that are destroyed on-site.

Comply with the Coastal Zone Management Act This act ensures protection of coastal resources including coral reefs, Lake Temae and wetlands. It limits development in coastal area, beaches and dunes and maintains public beach access.

Follow Hazardous Substances Regulations Here developers must limit pesticide use, certify personnel with restrictions on handling, storage, application and disposal of materials and eliminate use of chemicals banned in the United States.

Protect aquifers To protect ground water developers must control non-point source pollution such as irrigation and storm water runoff, monitor groundwater conditions and avoid chemical migration towards sensitive coral reefs.
### Estimated Environmental Impacts of Temae Golf Course Development

<table>
<thead>
<tr>
<th>GOLF COURSE INPUTS</th>
<th>EFFECTS</th>
<th>ESTIMATED QUANTITY/ YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>Wetland fill; hill side excavation</td>
<td>50 Hectares</td>
</tr>
<tr>
<td>Water</td>
<td>Draws down aquifers, runoff pollutants into surrounding ecosystem</td>
<td>400,000 to &gt; 2 million liters</td>
</tr>
<tr>
<td>Pesticides</td>
<td>Include herbicides, fungicides, and insecticides (sample)</td>
<td></td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Impairs nervous system function</td>
<td></td>
</tr>
<tr>
<td>Atrazine</td>
<td>Highly toxic to aquatic plants</td>
<td></td>
</tr>
<tr>
<td>Benfluralin</td>
<td>Decreases red blood cell count</td>
<td></td>
</tr>
<tr>
<td>Ncamba</td>
<td>Toxic to fish</td>
<td></td>
</tr>
<tr>
<td>Triphenylmethoxy</td>
<td>Decreases sperm formation, causes hyperthyroidism</td>
<td></td>
</tr>
<tr>
<td>Diquat</td>
<td>Causes cataracts</td>
<td></td>
</tr>
<tr>
<td>Pendimethalin</td>
<td>Toxic to liver</td>
<td></td>
</tr>
<tr>
<td>Disulfoton</td>
<td>Causes optic nerve degeneration</td>
<td></td>
</tr>
<tr>
<td>Total pesticide use</td>
<td>&gt;2 Tons</td>
<td></td>
</tr>
<tr>
<td>Fertilizers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Contributes to eutrophication of lakes; contaminates drinking water causing a threat to health of infants</td>
<td>10 Tons</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Increases algal growth which blocks sunlight and kills coral; in inland lakes eutrophies water. a process which removes oxygen, killing aquatic organisms</td>
<td>5 Tons</td>
</tr>
<tr>
<td>Wetland fill</td>
<td>Eliminates wetland function as a pollution filter; major contribution to sediment runoff, leading cause of coral death</td>
<td>55,000 Tons</td>
</tr>
<tr>
<td></td>
<td>500,000 cubic meters or 50,000 dump truck loads calculation: 25 hectares filled to a 2 meter depth; 100 kilograms/ cubic meter of soil; fill removed from hillside and placed in Lake Temae wetland</td>
<td></td>
</tr>
</tbody>
</table>

### GOLF COURSE IMPACTS

Lake Temae’s geology originates from both volcanic and coral sources. Underlain by a very porous layer of limestone where inland fresh water mixes with ocean salt water, Temae forms a single connected hydrologic unit between the land and the sea. No documented plan currently exists to manage the golf course in an environmentally sensitive manner. Under conventional golf course practices, chemical leaching from the addition of significant amounts of pesticides and fertilizers threatens the unique ecology of the lake, the health of the surrounding reef and the adjacent premier snorkeling and tourist site Temae Beach.

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1. Moorea was born as an underwater volcano, the source of the volcanic base rock.
2. Altante is soil which eroded off the volcano. This is the primary area where the golf course will be developed.
3. Lake Temae is at an intersection between freshwater and saltwater. Underlain by a very porous layer of carbonate where inland fresh water mixes with ocean salt water, Temae forms a single connected hydrologic unit between the land and the sea. (Burlot et al.)
**Lake Temae Species at Risk:**
In addition to introduction of pesticides and fertilizers, filling of the wetlands to facilitate development will destroy habitat for the locally rare Pacific Black Duck *Anas superciliosa*, the Wandering Tattler *Heteroscelus incanus*, the Pacific Golden Plover *Pluvialis fulva* and the Little Heron *Butorides striatus*.

**Analysis of Regulatory Context**
Analysis of Moorea’s terrestrial zoning plan (PGA) policies reveal that current planning regulations for tourism zones are inconsistent with the goals of the Marine Management Plan (PGEM) as they encourage large scale tourism development in the vicinity of important marine protected areas (MPAs) and fail to control inputs from reaching the marine environment that potentially could cause significant harm to marine ecosystems.
Recommendations

Our analysis suggests that development of the golf course is a risky venture for the island. Current terracing of the hillside and filling of the wetlands point to discrepancies between the stated design standards and observed construction practices, yet the development of the golf course at lake Temae continues. Despite this, implementing the following management practices can help circumvent further damage.

GREEN GOLF PRINCIPLES

- Limit fertilizer applications, and use slow release fertilizers to avoid “pulses”
- Design and operate irrigation to prevent movement of water into wetlands and to reduce chemical transport and disruption of the natural hydrologic cycle.
- Consider chemical properties such as solubility, leaching potential, half-life, and degradation products when selecting chemicals for application.
- Establish Integrated Pest Management (IPM) as an alternative to pesticide application.
- Select turf appropriate for climate/environment to reduce need for irrigation.
- Establish buffer strips along wetland perimeter.
- Store chemicals such as pesticides, fertilizers, and fuel in a location where their spill will not result in their transport to wetlands.
- Avoid wetlands in course design routing.
- Collect and re-use drainage water from the golf course, creating a closed water system.
- Choose a course aesthetic that lowers maintenance standards such as promoting a scruffier and seasonal appearance over constant greenness. This minimizes nutrient and irrigation applications, which controls disease and lessens the need for costly pesticide and fungicide applications.
- Allow dynamic natural processes to function within the course.