Impacts of Land Use Change on Local Aquatic Resources

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Aquatic Resources Affected by Land Use

- Guts
- Groundwater
- Wetlands
- Coral Reefs

Land Uses and Potential Impacts

- Construction
- Dredge/Fill
- Agriculture

- Erosion
- Sedimentation
- Loss of vegetation
- Loss of biodiversity
- Loss of ecosystem services

Healthy Guts

- Guts connect land to sea (transport)
- Habitat for rare/endangered species
- Filtration of surface runoff
- Recharge of groundwater
- Reduce flooding


NRCS

Impacted Guts

- Guts connect land to sea (transport)
- Erosion
- Sedimentation
- Gullies and cave-ins
- Loss of vegetation (filtration, recharge, increase velocity and future erosion potential)


NRCS


NRCS

Impacts to groundwater

- Increase in impervious surfaces - less recharge
- Population increases - more water consumption
- Less available groundwater - need for desalinated water increases

Healthy Wetlands

- Important habitat for local and migratory species
- Nursery habitat
- Filtration of runoff
- Containment of sediments, pollutants, nutrients – protect offshore resources
- Recharge of groundwater
- Storm protection

Impacts to Wetlands

- Increased upland loads – sediment, pollutants, nutrients
- Filling of wetlands for development
- Draining of wetlands for development
- Loss of vegetation due to construction/development
- Illegal dumping

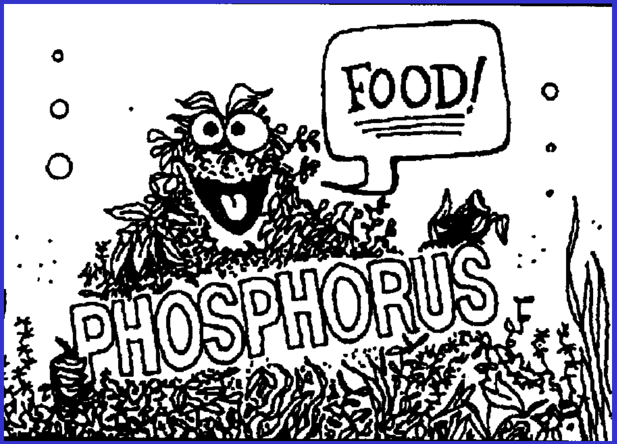
Healthy Coral Reefs

- Biodiversity
- Income (tourism, food)
- Fisheries
- Beach creation
- Recreation
- Shoreline protection
- Natural products

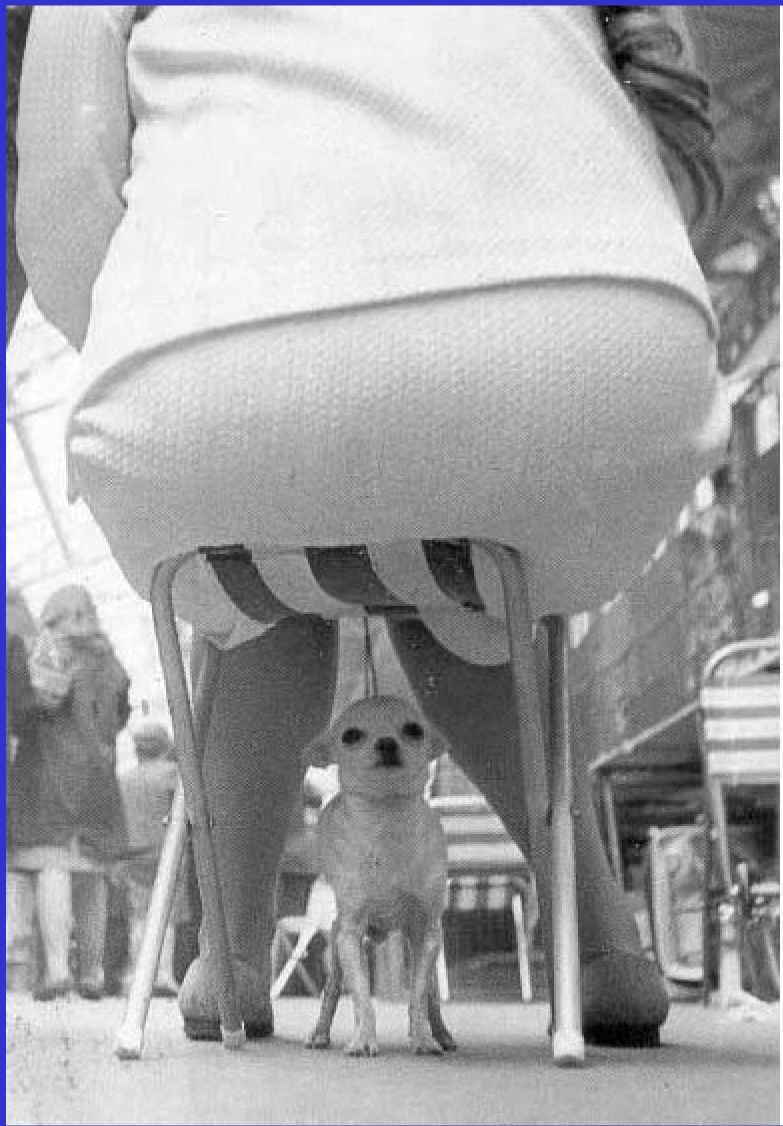
Impacts to Coral Reefs

- Sedimentation
- Increased nutrients
- pH changes
- Salinity changes
- Marine Debris
- Pollution
- Physical damage
- Increased sea surface temperatures

How does increased runoff affect our coral reefs?



- Nutrient loading = algae blooms, eutrophication
- High turbidity = less light penetration, reduced photosynthesis
- Smothering of organisms
- Abrasion
- Reduced recruitment, reproductive success
- Mean sedimentation rates for non-stressed reefs, <1 to ~10mg/cm^2/day (Rogers, 1990)
- Mean TSS for non-stressed reefs, <10mg/l (Rogers, 1990)



And you think YOU have stress?

How corals deal with sediment

- Use of tentacles and cilia
- Entrap particles in mucous and slough off
- Stomodeal distension by taking in water
- Colony and calyx morphology important
- Currents can help to remove sediment -saves coral animal from expending energy to rid itself of excess sediment

Expectations in the presence of heavy sedimentation

- Lower species diversity
- Less percent cover
- More forms/species that are sediment/turbidity resistant
- More smaller colonies
- More larger colonies
- Lower growth rates
- Upward shift in depth zonation
- More branching growth forms

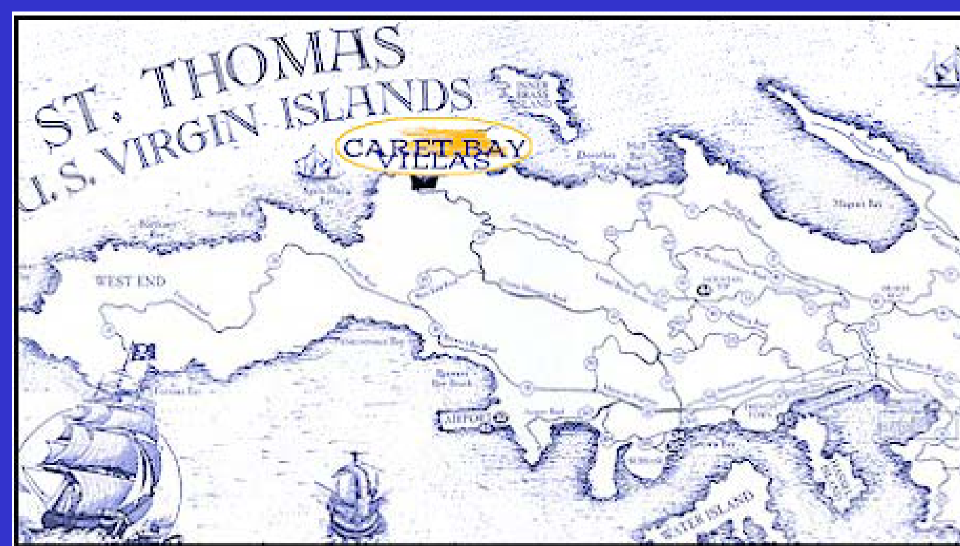
VIMAS, 2001

Caveats

- Difficult to link a response to one stressor
- Species differ in their tolerance levels and ability to rid themselves of sediment
- Amount and type of sediment matters
- Lab and field responses can differ
- Each case must be evaluated individually

Caret Bay, St. Thomas, USVI

(Nemeth and Nowlis, 2001)



Caret Bay (Nemeth and Nowlis)

- Construction project
- CZM required builder to install BMP’s and fund reef monitoring program
- 2 natural guts on site
- Steep hillsides, less than 50m from shoreline
- Fringing reef slopes to 10m, then sharp drop to 15m
- Forereef composed of large coral colonies

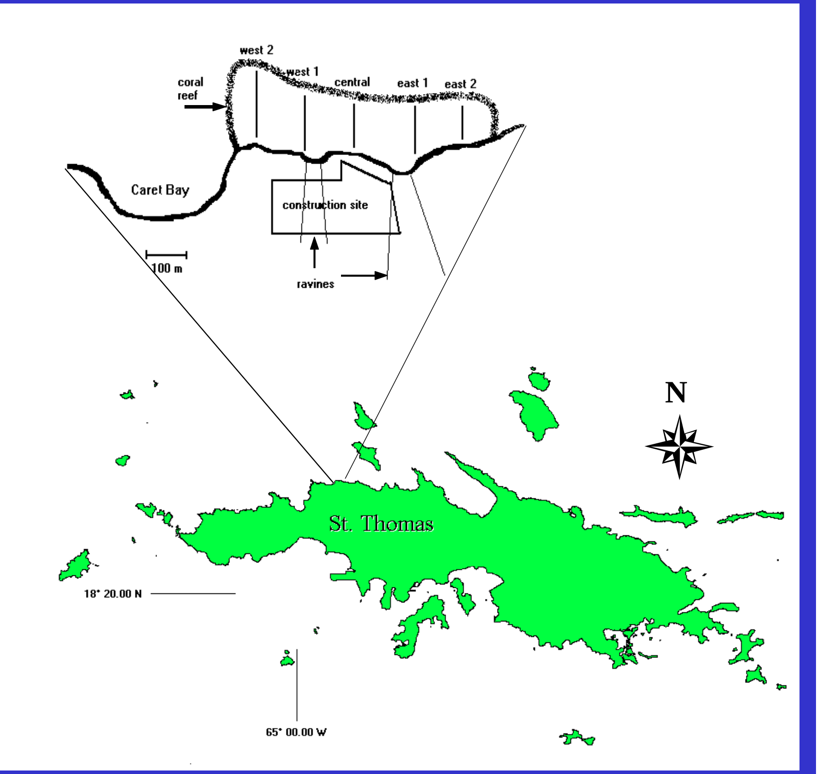
Caret Bay Objectives

- Measure rates of sedimentation onto reefs
- Monitor water quality
- Quantify changes in abundance and diversity of corals
- Document acute and chronic effects of sedimentation
- Develop management guidelines for evaluating the effectiveness of sediment control measures

(Nemeth & Nowlis, 2001)

Caret Bay Methods

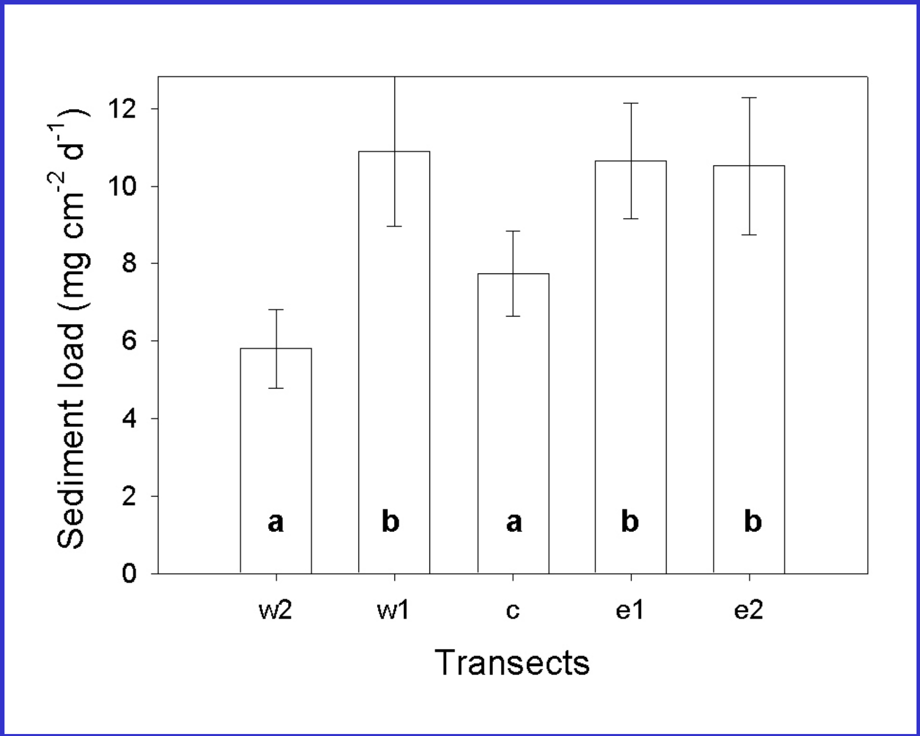
- Sediment (chronic and flux of terrigenous sediment - monthly)
- Seawater analysis (TSS, turbidity - monthly)
- Rainfall (site rain gauge – daily)
- Corals
    - Percent cover of corals and algae; stress signs (quadrats)
    - Focused monitoring of *P. astreoides* and *M. faveolata* (photographed)



(Nemeth & Nowlis, 2001)

Caret Bay Findings

- Eroded sediments deposited in proximity to gut outlets

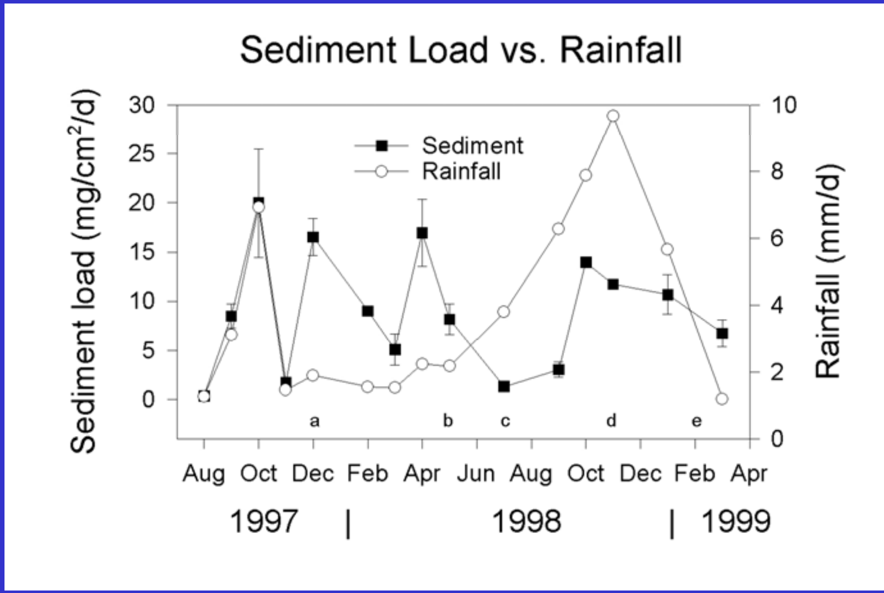


Average sediment load (± SE) from August 1997 to March 1999 among the five transect. Bars with the same internal letter were not significantly different (ANOVA, a=0.05).

(Nemeth & Nowlis, 2001)

Caret Bay Findings

- Eroded sediments deposited in proximity to gut outlets
- Sediment runoff related to construction schedule

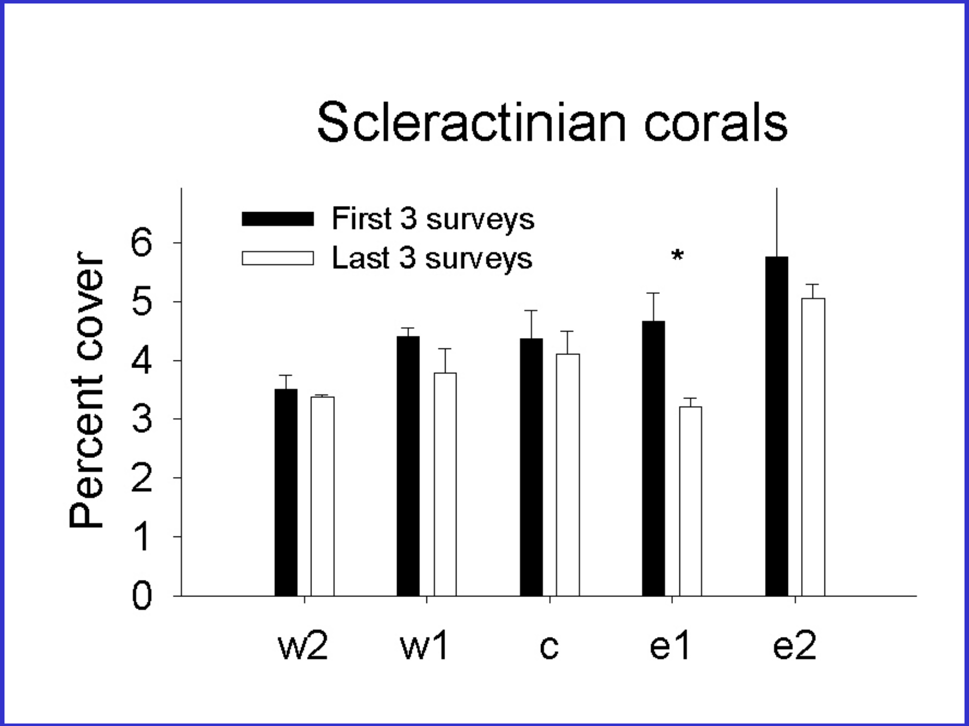


Sediment load (± SE) in relation to average daily rainfall and progress of development: a) building foundations complete, b) 60% of roads paved, c) 90% of roads paved, d) all roads paved, e) 80% landscaped

(Nemeth & Nowlis, 2001)

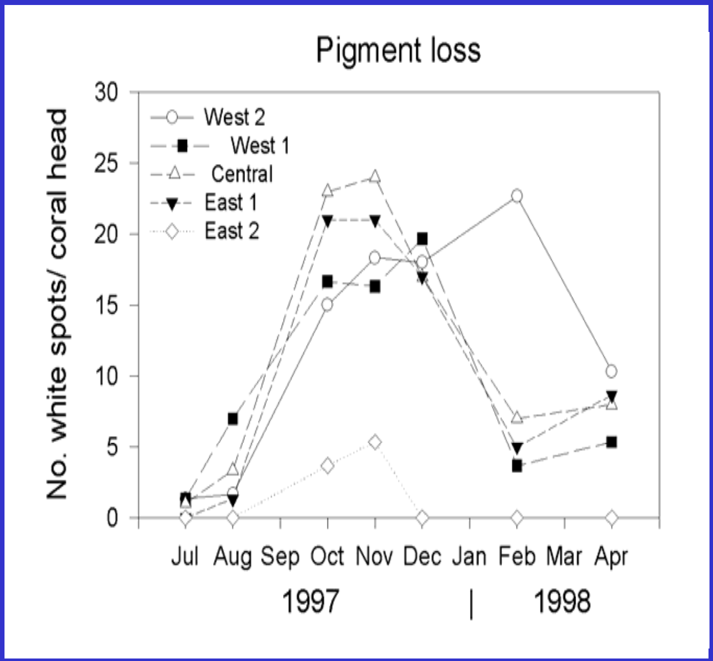
Caret Bay Findings

- 14% decline in percent cover across study sites
- Bleaching of corals correlated to sediment rates

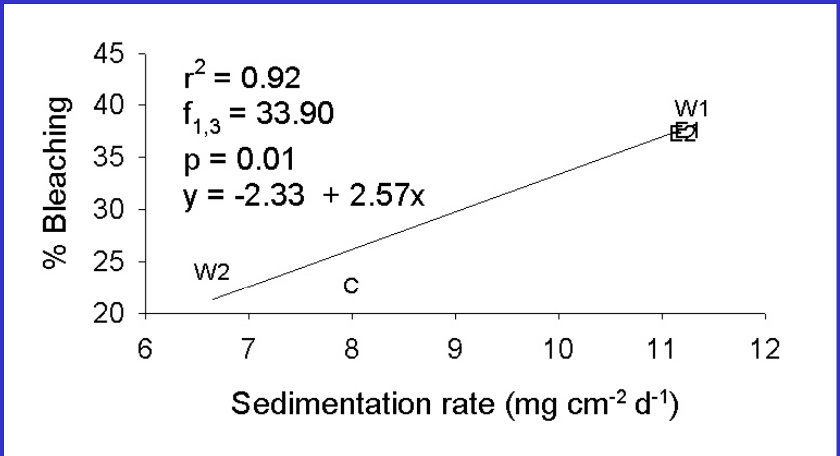


Percent cover of corals at Caret Bay study site during the first 3 (pre-construction) and last 3 (post-construction) reef surveys. One-way ANOVA revealed significant differences among transects for corals. Paired T-tests of coral abundance between pre-and post-construction surveys indicated a significant decline in coral cover on transect e1 ($t=3.67$, $df=2$, $P=0.03$)

(Nemeth & Nowlis, 2001)



Development of white spots counted on M. faveolata coral heads (n=3 per transect) using monthly photographs



Relationship between average sedimentation rate and % bleaching during the first 3 and last 3 reef surveys of the five transects.

(Nemeth & Nowlis, 2001)

Effects of runoff on coral reproduction (Richmond, 1993)

- Most coral simultaneous hermaphrodites; broadcast spawn
- Many spp. spawn on same night or within similar time frames
- Many spp. only spawn once/yr
- Objective: determine if reproductive failure on up-current "source" reefs combined with sedimentation could be reason for declining coral cover and recruitment levels

Runoff & Reproduction Methods

- Collection of gametes from *A. digitifera* in Okinawa
- Placed eggs into 3 fertilization treatments
  - Eggs alone in filtered seawater
  - Eggs with sperm from different colony
  - Eggs, sperm in presence of coastal water sample (lower salinity, higher turbidity)

Runoff & Reproduction Findings

- After 10hrs. no eggs from control fertilized; 72% of experimental control eggs fertilized; 34% of experimental eggs fertilized
- All the experimental control fertilized eggs developed into planulae
- Only 51% of the coastal water fertilized eggs developed successfully

Runoff & Reproduction Findings

- Terrestrial runoff can interfere with reproduction, development and subsequent recruitment
- Coral reefs may suffer decline through attrition and reproductive failure
- Reefs removed from sedimentation could be adversely affected by coastal runoff through loss of recruits from affected reef areas

Caution – Mature Content Ahead

Considerations for Management?