

# North Shore Greenprint

## Description of Mapping Results

### Greenprint Model Basics

- The Greenprint Model uses systematic, GIS-based analysis to translate stakeholder objectives into location-specific land conservation priorities:
  - Goal and Criteria Identification
    - Stakeholders identify conservation goals
    - A Technical Advisory Team assists in defining measurable, mappable criteria that characterize each goal. Criteria are grouped by goal.
    - Relative weights are assigned to each criterion..
  - Criteria Modeling
    - Using GIS modeling, regional datasets are translated into a “priorities map” for each conservation criterion. Criteria maps are expressed in terms of conservation value, on a scale of 0-5.
  - Criteria Aggregation Modeling using Hierarchical Analysis
    - Custom weighted overlap analysis is used to combine each group of weighted criteria into a priorities map for each goal. Goal maps are expressed in terms of conservation value, once again on a scale of 0-5.
- The TPL Greenprint Model offers a unique blend of science and preference:
  - Criteria models are designed by local experts and scientists using best available regional data.
  - Weighted criterion aggregation reflects the preferences and priorities of local stakeholders. The weights designate relative perceived importance for each criterion.

### North Shore Greenprint Goals and Modeling Criteria

A Technical Advisory Team assisted in defining measurable, mappable criteria that characterize each goal. Criteria are grouped by goal:

#### Protect Agricultural Lands :

- Opportunities to protect cultivated agricultural land
- Uncultivated agricultural lands
- Places for community gardens
- Proximity to people
- Agricultural land adjacent to schools

#### Preserve Cultural and Historic Places :

- Cultural places
- Historic places

#### Protect Coastal Region:

- Buffer coastline on and off shore
- Surfing locations
- Protect near shore water quality
- Marine managed areas
- Unused lands that support public and local business recreational activities

Protect Natural Habitats for Plants and Animals:

- Marine and coastal resources
- Native forests
- Wetlands
- Important and rare plant and animal habitats
- Large contiguous tracts of land used by native species
- Adjacent to existing protected land
- Possible new marine management areas

Increase Recreation and Public Access Opportunities:

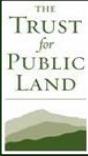
- Connect communities with bike lanes and paths
- Surfing locations
- Undeveloped coastal lands
- Improve access to beaches
- Access to trails in uplands
- Undeveloped parks and adjacent to existing parks
- Improve access to existing cultural areas
- Submerged lands and coral reefs

Preserve and Enhance View Planes:

- Expansive agricultural views
- Views of seashore
- Mountaintops
- Lands along side of Kaukonahua Road
- Views from ocean looking Inland
- Views regularly filmed for TV and movie industry

Protect Water Quality and Quantity:

- Stream and waterbody buffers
- High recharge areas for aquifers
- Wetlands
- Highly erodible areas
- Upland forested areas
- Areas of high rainfall concentrations
- Natural freshwater springs
- Bluffs above stream gulches



## North Shore Greenprint Model

### Kahuku to Ka'ena, Mauka Makai

#### Model Criteria

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1	2	3	4	5	6	7
Goal	Goal Weights	Criteria	Criteria Weights	Methodology	Data (Description, Date)	Data Source
<b>Protect Agricultural Lands</b>						
		Opportunities to protect cultivated agricultural land	<b>34%</b>	Model Description: Identified all cultivated land from landcover data, Cultivated land that overlaps prime or unique farmland types are high priority (5), Those that overlapped Important types are moderate-high priority (4) and all other cultivated lands are a moderate priority (3).	2005 Landcover Important Agricultural Lands	NOAA Honolulu City County website
		Uncultivated agricultural lands	<b>21%</b>	Model Description: Identified all State Landuse District data set as agriculture. Those that overlap unique and prime agricultural lands are high priority (5); those areas that overlapped important agricultural lands are moderate-high priority (4), . All remaining agricultural land use are a moderate priority (3). Impervious surface removed. Cultivated Land was removed.	State Landuse Districts Important Agricultural Lands 2005 Landcover 2005 Impervious Surface Zones of preEuropean Agriculture	Honolulu City County website State of Hawaii State Hawaii GIS website State Hawaii GIS website TNC
		Places for community gardens	<b>13%</b>	Model Description: The high population density areas were identified using block group data and determining the population density of each block group. Natural Breaks were used to find the denser block groups, which had at least a density of 8 people per acre. These dense block groups were buffered by 500 meters and then again by another 500 meters to create 2 proximity zones. Priorities in the outer zone are penalized 1 point. Cultivated lands from landcover within the inner buffer of 0-500 meters were given a high priority (5). Agricultural lands of Importance were given a moderate-high priority (4), Potential agriculture from landuse district data was given a moderate priority (3). Cultivated lands from landcover in the outer buffer 500-1000 meters were moderate -high priority (4), agricultural lands of importance given a moderate priority (3), and potential from landuse a moderate-low priority (2). Blocks smaller than 1 acre were removed.	2000 Census Block Groups State Land District 2005 Landcover Important Agricultural Lands 2005 Impervious Surface	Honolulu City County website Honolulu City County website State Hawaii GIS website State of Hawaii State Hawaii GIS website
		Proximity to people	<b>11%</b>	Model Description: The high density areas were identified using block group data and determining the population density of each block group. Natural Breaks were used to find the denser block groups, which had at least a density of 8 people per acre up to 135. These dense block groups were buffered by 500 m to form an inner ring and then buffered again to form an outer ring. Cultivated lands from landcover within the inner buffer were given a high priority of (5). Cultivated Lands in outer buffer were penalized 1 point and are moderate-high priority (4). All blocks less than 1 acre removed. Criteria prioritizing existing farms near people.	2000 Census Block Groups 2005 Landcover 2005 Impervious Surface	Honolulu City County website State Hawaii GIS website State Hawaii GIS website
		Agricultural land adjacent to schools	<b>8%</b>	Model Description: Identified all schools, buffered schools by 1/4 mile, all existing cultivated land from landcover within buffer are high priority (5), Criteria focused on existing farms near schools.	2005 Landcover Public Schools 2005 Impervious Surface	State of Hawaii State of Hawaii State of Hawaii

Preserve Cultural and Historic Places						
	Cultural places	<b>55%</b>	Model Description: Buffer cultural streams and fish ponds by 100 meters. Identified all cultural places as high priority (5).	Cultural Places Cultural Important Streams Zones of preEuropean Agriculture Fish Pond Points Fish Pond Polygons	State Historic Preservation State Hawaii TNC State of Hawaii Website State of Hawaii Website	
	Historic places	<b>45%</b>	Model Description: Identified all historic places as high priority (5).	Historic National/State Registry Places Historic Locations Haleiwa Special District	State Historic Preservation State Historic Preservation Honolulu City County website	
Protect Coastal Region						
	Buffer coastline on and off shore	<b>25%</b>	Model Description: Buffered shoreline 1/4 mile seaward, and used SMA boundary for landward side buffer. These buffers merged to form the coastline study area. Within this area, all, Anchialine pools, Green Turtle Areas, Intact Native Habitats, Monk Seal Habitat, Spinner Dolphin Rest Areas, Water Bird Recovery Areas, and Seabird Nesting Areas are high priority (5). Of the remaining landward area, prioritized based on landcover: wetlands = 5, Natural Types = 4, Open Space Developed = 3, Cultivated Land = 1. Near shore coral locations from nautical charts = (5). Offshore, used the Benthic Habitats of the Main Hawaiian Islands data, all high percentage covers for coral, microalgae, coralline algae, turf and seagrass are a (5), low density of coral = (4), low percentage of microalgae, turf and Coralline Algae are a (3). Any priority area that overlapped a high erosion beach was penalized 1 point.	Coastline Special Management Areas Study Area Benthic Habitat Coral Reef Locations Nautical Charts Native Habitat Assessment Erosion Potential Anchialine Pools Water Bird Recovery Areas Coastal Seabird Nests Spinner Dolphin Resting Areas Monk Seal T and E Plants and Habitat 2005 Landcover 2005 Impervious Surface Green Turtle Areas	State of Hawaii GIS website State of Hawaii GIS website TPL created NOAA State of Hawaii GIS website TNC USGS TNC TNC TNC TNC TNC TNC State of Hawaii GIS website Planning Dept. TNC	
	Surfing Locations	<b>25%</b>	Digitized surfing locations identified in numerous websites. All locations are high priority (5).	Surfing Locations	TPL Digitized based on websites	
	Protect near shore water quality	<b>20%</b>	Model Description: Clipped all streams to SMA boundary. Buffered 100 meter, prioritized within buffer based on landcover: developed types = 0, openspace developed and cultivated = Moderate-High (4) , all natural landcover types = 5. Areas not considered part of drinking water source areas and wells are more permissible with natural landcover = 3, openspace and cultivated = 2.	Detailed Roads 2005 Landcover Streams Lakes Special Management Areas Underground Injection Zones	ESRI State of Hawaii GIS website State of Hawaii GIS website ESRI State Hawaii GIS website Honolulu	
	Marine Managed Areas	<b>17%</b>	Model Description: Two regulated fisheries areas at Pupukea and Waialua Bay were buffered 100 ft, all areas high priority (5). Fish pond data had a class attribute, all class 1 are excellent fisheries, so prioritized as a (5). There are no class 2, class 3 are poor to fair fishing ponds, so rated as a moderate priority (3).	Fish Pond Points Fish Pond Polygons TPL created from 5 yr Plan Marine Managed Areas Fishing Reserves	State of Hawaii Website State of Hawaii Website 5 Year Sustainable Plan - TPL State of Hawaii Website	
	Unused Lands that support public and local business recreational activities	<b>13%</b>	Model Description: Buffered SMA, MMA and Surfing Reserves by 1/4 mile. Clipped this buffer to SMA boundary. All impervious, agriculture, wetlands and water from landcover within buffer were removed. Natural and Bare land types are all high priority (5). All Beach parks buffered 500 feet offshore to prioritize water off beach parks as high priority (5).	2005 Landcover Surfing Locations Marine Management Areas Recreation SubZones Recreation Zones Protected Lands and Parks	State of Hawaii Website TPL Created From Imagery State of Hawaii Website State of Hawaii Website State of Hawaii Website Several Data providers	

NH: Protect Natural Habitats for Plants and Animals						
	Marine and coastal resources	<b>18%</b>	Model Description: Buffered coastline by 1/4 mile on seaward side, buffered the landward side by using elevation to get areas along coast up to 25 meters above sea level. Merged these two to set the criteria boundary. All natural landcover within this border was at least a moderate priority (3). Used coastal vegetation data to determine species richness of segments of coastline, natural landcover along lower species richness coastlines were moderate-high priority (4). High species richness coastlines are (5). All water bird recovery areas, coral reef boundaries and fish ponds were also a high priority (5).	Study Area Coastal Vegetation Assessment Coastline Elevation Fish Pond Points Water Bird Recovery Areas Benthic Habitat Coral Reefs - Nautical Charts Fish Pond Polygon 2005 Landcover	TPL TNC State of Hawaii GIS website USGS State Hawaii GIS website TNC NOAA State of Hawaii GIS website State of Hawaii GIS website State of Hawaii GIS website	
	Native forests	<b>17%</b>	Model Description: Identified all forest types from landcover, overlapped with Native Habitat Assessment, all intact high diversity ecosystem types = 5, Intact = 4, and Threatened Native Ecosystems = 3. Forest types that did not overlap are (0) not a priority.	2005 Landcover Native Biodiversity Assessment	State of Hawaii GIS website TNC	
	Wetlands	<b>15%</b>	Model Description: Identified Ukoa Marsh and Loko Ea Fishpond, made high priority (5). All wetlands that overlapped rare and endangered species data were assigned high priority (5). Selected out observations before 1980. All remaining wetlands that overlapped native habitat data from TNC were assigned high priority (5). All remaining wetlands were weighted by size, 1-15 acres = (3), 15-54= (4) and 54+=(5).	Wetlands Wetlands Habitat Quality Assessment Fish Pond Locations Plant Critical Habitat Water Bird Recovery Areas Rare Species Location Oahu Rare Plants on Army Installations Rare Plant Locations NHP Element Occurrence of Rare Species	State of Hawaii GIS website NWI TNC TPL created State of Hawaii GIS website TNC Hi'ipaka LLC Army Hi'ipaka LLC Hi'ipaka LLC	
	Important and rare plant and animal habitats	<b>15%</b>	Model Description: Assembled known data that represents critical habitat or species locations. Used a summation approach to get priority. All E/O and unique Rare Army point locations provided 1 point to the sum. Critical Habitat for plants, monk seal, green turtles, snails, picturewing and other rare species also added 1 point. Wading bird habitat added 1 point. Forest Bird Ranges scores depended on species richness, 1-3 points. Coastal Seabird Nests that were very good or good = 2 points, Fair or Poor = 1 point. Water bird Recovery areas identified as Core = 2 points, supporting = 1 point. T and E Plant concentrations that were very high or high = 3 points, medium conc. = 2 points, low conc. = 1 point. Overlapping values summed and priority assigned using Natural Breaks on 4 classes. Range of priority 2-5.	Rare Plants on Army Grounds Rare Species E/O Coastal Seabird Nests Critical Habitat for Plants Rare Species Locations Forest Bird Ranges (inc. Elepaio) Water Bird Recovery Areas T and E Plant Concentrations Critical Habitat Picture Wing Wading Bird Habitat 2005 Landcover Monk Seal Green Turtle Snails Waianaei Snails Koolauin	Army TNC TNC State of Hawaii GIS website Hi'ipaka LLC TNC TNC State of Hawaii GIS website State of Hawaii GIS website Army Army	
	Large contiguous tracts of land used by native species	<b>14%</b>	Model Description: Identified blocks of unfragmented contiguous natural habitat, agriculture not included. All blocks less than 10 acres removed. If a NHP E/O intersected the block, it was a moderate priority (3). If the TNC biodiversity assessment, rated 32% as threatened native habitat or better it was assigned a (5). If the percentage of native habitat was 32% or less then it was a (4). 32% was the mean.	Roads Study Area 2005 Landcover Biodiversity Summary Rare Species Element Occurrence Data	ESRI TPL State of Hawaii GIS website TNC TNC	
	Adjacent to existing protected land	<b>12%</b>	Model Description: selected protected lands greater than 10 acres. Identified contiguous blocks from landcover, selected all greater than 10 acres. Selected blocks that were adjacent to existing protected land. Overlapped scoring schem for NH04 results. Removed existing protected lands from results. Protected lands for this criteria include all parks (developed and undeveloped) , reserves and DOD land.	Protected Lands Roads 2005 Landcover	Various ESRI State of Hawaii GIS website	
	Possible new marine management areas	<b>9%</b>	Model Description: identified preferred habitat for invertebrates and fish, area with coral near shore and those from the assessment where coral cover was greater than 50%. Those that overlapped a known location from the recreation survey showing where fishing was occurring, these areas are high priority (5), areas where no fishing was observed are moderate priority (3).	Benthic Offshore Habitat Coral Reef Locations Naut. Charts Near Shore Fish and Invertebrate Habitat Coastline Recreation Survey	TNC Planning Website TNC State of Hawaii GIS website Dept Planning	

Increase Recreation and Public Access Opportunities						
		Connect communities with bike lanes and paths	<b>19%</b>	Model Description: Buffered all proposed bike trails, paths and lanes by 20 meters and prioritized as high priority (5).	Proposed Trails	Honolulu City County website
		Surfing Locations	<b>19%</b>	Digitize surfing locations identified in numerous websites. All locations are high priority (5).	Surfing Locations	TPL Digitized based on websites
		Undeveloped coastal lands	<b>17%</b>	Model Description: All parcels with zero living units were selected, those that are within 100 meters of coastline are prioritized as high priority (5).	Parcels - vacant Joining Table Study Area Coastline	Honolulu City County website Honolulu City County website TPL State of Hawaii GIS website
		Improve access to beaches	<b>13%</b>	Model Description: Used the web to find all publically accessible beaches. Buffered by half mile to find all unaccessible beaches. Removed sensitive areas such coastal bird nesting sites and water bird recovery areas. Of the remaining beaches, those that were within 50 meters of a road were high priority (5), the rest were moderate priority (3).	Coastline Important Places 2005 Landcover Coastal Seabird Nests Water Bird Recovery Areas Detailed Roads	State of Hawaii GIS website State of Hawaii GIS website State of Hawaii GIS website TNC TNC ESRI
		Access to trails in uplands	<b>9%</b>	Model Description: Buffered trails and roads by 100 meters, where there was overlap assigned high priority (5).	Detailed Roads Na Aha He Ie Trails Kaena Point Trailhead	ESRI State of Hawaii GIS website TPL
		Undeveloped parks and adjacent to existing parks	<b>8%</b>	Model Description: Select all undeveloped city parks and future parks and prioritized as high priority (5). Selected all developed city parks and selected all parcels with no building units on the property that were within 100 feet of these parks and prioritized the portion of the parcel as high priority (5) that is within 125 meters of the park.	Parks	Honolulu City County website
		Improve access to existing cultural areas	<b>8%</b>	Model Description: Buffered cultural sites and roads by 50 meters, where they intersected was prioritized. All intersecting buffers from historic sites and preservation district are high priority (5). Buffers along streams were based on number of significant locations found on that river, if 10 it was a high priority (5), if 3 or 4 it was moderate priority (3). These were the only values in the study area.	Streams Cultural Assessment National Historic Sites Historic Preservation District Roads	Hawaii State GIS website State Historic Preservation ESRI
		Submerged lands and coral reefs	<b>7%</b>	Model Description: All coral locations from Nautical charts are high priority (5). All Coral Habitat where coral was greater then 50% of the cover high priority (5). All Coral Habitat where coral was 10%-50% of the cover moderate priority (3).	Coral Reef Locations Nautical Charts Benthic Habitats	State of Hawaii GIS website TNC

Preserve and Enhance View Planes						
	Expansive agricultural views	<b>22%</b>	Model Description: Identified cultivated land in landcover, those contiguous blocks of agricultural land that were within 50 meters of Kamehameha Highway and Kaula Road are prioritized as high priority (5).	2005 Landcover 2005 Impervious Surface County Routes State Routes		State of Hawaii Website State of Hawaii Website State of Hawaii Website State of Hawaii Website
	Views of seashore	<b>22%</b>	Model Description: Used Flickr to create points where photos had been taken and geotagged, use searches for "Ocean", "Seashore", and "Sunset". These points buffered by 10 meters and were given high priority (5). Also selected state road 930 and 83, as well as county roads 8300, 9263 and 9262 as roads to view from, buffered 15 meters and selected each block of land that adjoined the roads, that were bare land, Bare land blocks near road assigned moderate-high priority (4).	2005 Landcover State Routes County Routes Seashore Photos Flickr Ocean Photos Flickr		State of Hawaii Website State of Hawaii Website State of Hawaii Website TPL created Flickr site TPL created Flickr site
	Mountaintops	<b>17%</b>	Model Description: Identified high elevation areas using DEM. Natural Breaks for priority level: 0-351 meters = (0) Not a Priority; 351-500 meters moderate priority (3); 500-693 meters moderate-high priority (4); 693-1233 meters high priority (5). Then added in specific mountain tops for Pupkea and bluffs above Waimea, these areas assigned high priority (5).	Polygon to focus analysis on Pupukea Polygon to focus analysis on Waimea Viewpoints to see Pupukea Elevation Viewpoints to see Waimea		TPL created TPL created TPL created USGS TPL created
	Lands along side of Kaula Road	<b>14%</b>	Model Description: Ran Viewshed analysis for the whole road. Limited results to areas that could be seen on the west side up to 7 km. Viewable types include evergreen, grassland, cultivated, bare land and open space-developed.	County Routes Elevation		State of Hawaii Website USGS
	Views from ocean looking Inland	<b>14%</b>	Model Description: Created view plane sight lines using the North Shore Sustainable Communities Plan as a guide and ran a viewshed analysis. Non natural landcover types removed.	Elevation Panoramic Views 2005 Landcover		USGS TPL created from 5 Year Sustainable Community Plan State of Hawaii Website
	Views regularly filmed for TV and movie industry	<b>11%</b>	Model Description: Digitized locations using imagery to find locations on map from Oahu film office. These locations are a high priority (5).	Oahu Movie Locations Drive		<a href="http://www.discoverinhawaii.com/">http://www.discoverinhawaii.com/</a>

Protect Water Quality and Quantity						
	Stream and waterbody buffers	<b>18%</b>		Model Description: All intermittent and perennial streams have 100 meter buffer, does not include ditches. Also included all perennial reservoirs and lakes from Street Map Local Lakes Data, which was better than local waterbody data as it lumped many waterbodies into a single record. Resource value data was not included as it was rating species use of the stream, not water quality itself. Within buffer, priority set using landcover, developed types no priority (0), openspace developed and cultivated moderate priority (3), all natural landcover types high priority (5).	Detailed Roads 2005 Landcover Streams Lakes	ESRI State Hawaii GIS website State Hawaii GIS website ESRI
	High recharge areas for aquifers	<b>17%</b>		Model Description: Slopes greater than 25 degrees were removed. All Impervious surface was removed. All Storm basins high priority (5). Prioritization score created using slope and rainfall amounts. Low slope and higher rainfall amounts were higher priority. Higher slopes, up to 25 degrees, with less rainfall were given lowest score = 2. Slope categories: 0-5=5, 5-10=4, 10-15=3, 15-25=2; Rainfall categories: 31-50 in=0, 50-94=20, 94-153=30, 153-217=40, 217-281=50.	Digital Elevation Model (DEM) Aquifers 2005 Impervious Surface Stormwater Basins Rainfall	USGS State of Hawaii GIS website State of Hawaii GIS website Honolulu City County website Rainfall Atlas
	Wetlands	<b>15%</b>		Model Description: Used data from state website derived from USGS maps and aerial imagery. Includes many types of wetlands such as Estuarine, Freshwater Emergent, Freshwater Shrub and Riverine. All types treated equally, high priority (5).	Wetlands Wetlands	State of Hawaii GIS website NWI
	Highly erodible areas	<b>13%</b>		Model Description: Identified Highly erodible soils and set as high priority (5), potentially highly erodible as moderate-high priority (4). Everything else not a priority (0). Impervious areas within erodible types removed.	Soil - Highly Erodible Soil - Potentially Highly Erodible 2005 Impervious Surface	State of Hawaii GIS website State of Hawaii GIS website State of Hawaii GIS website
	Upland forested areas	<b>11%</b>		Model Description: Identified all forest landcover types from landcover data. If forest was inside the boundary of a protective or coastal subzone, it was given high priority (5). If inside a limited or resource subzone, it was given a moderate-high priority (4), if in a general subzone it was given a moderate priority (3) and if it was unclassified, it was a low-moderate priority = (2).	2005 Landcover Coastal Sub-Zone	State of Hawaii GIS website State of Hawaii GIS website
	Areas of high rainfall concentrations	<b>10%</b>		Model Description: Used a Natural Breaks to determine degree of priority: 31-81 inches = 1; 81-131 inches = 2; 131-181 inches = 3; 181-231 inches = 4; 231-281 inches = 5.	Rainfall	Rainfall Atlas
	Natural freshwater springs	<b>8%</b>		Model Description: used geonames, identified 1 spring in study area, buffered point by 100 feet and assigned high priority (5).	Geonames - Springs	State of Hawaii GIS website
	Bluffs above stream gulches	<b>8%</b>		Model Description: used USGS DEM data to find degree of slopes, all slopes greater than 50 degrees that are within 100 meters of a stream were selected and set to high priority (5)	Digital Elevation Model (DEM) Streams	USGS State of Hawaii GIS website