CRIME MAPPING APPLICATIONS FOR HAWAI`I'S JUVENILE JUSTICE INFORMATION SYSTEM

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Crime Prevention & Justice Assistance Division
Department of the Attorney General
State of Hawai`i

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Foreword

This report presents an exploration of the potential of computerized mapping technologies, or geographic information systems (GIS), for justice assistance in Hawai`i. Many jurisdictions across the nation have adopted GIS technology in order to improve effectiveness across a range of areas, from policing to social service delivery. In the area of justice administration, crime mapping and the spatial analysis of crime are becoming integrated to augment existing information systems and research techniques. The Department of the Attorney General is thus interested in utilizing GIS technology to enhance the work of various justice and social service activities within Hawai`i.

The objective of this report is to dually demonstrate the applicability of GIS technology and the Juvenile Justice Information System (JJIS). The JJIS is administered by the Department of the Attorney General and is a collaborative information exchange network that spans the continuum of police, prosecutors, Family Court, and corrections. While a single study is unable to provide an exhaustive examination of the research possibilities for GIS technology and the JJIS, our report provides a glimpse of how GIS technology can aid an understanding of juvenile delinquency, while also demonstrating the transformation of JJIS data into policy-relevant information. Indeed, it is only through the availability of comprehensive, objective data and analyses that policymakers are able to best determine how to prevent and respond to juvenile crime in our state.

Our report is written for a lay audience, and features an introduction to GIS technology as well as illustrations utilizing JJIS data. Reference tables accompanying maps are also included. It is our hope that the report will spark ideas as to how GIS technology might be useful to various agencies and organizations involved in youth services and juvenile justice administration. Crime mapping, along with more sophisticated forms of spatial analysis that are not covered in this introductory report, can prove invaluable for needs and assets assessment, policy design, resource allocation, strategic planning, and the evaluation of outcomes and effectiveness. With sustained financial and other support, and as the JJIS is updated in response to the needs of the juvenile justice system and related agencies, we anticipate that GIS technology will play an important role.

Mark J. Bennett
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Table of Contents

Foreword.....i

Acknowledgements..... ii

Table of Contents..... iii

List of Tables..... v

List of Figures..... vi

List of Maps.....vii

Introduction..... 1

Section 1: Crime Mapping and Its Potential Applications in Hawai`I 2

Mapping as a Case of Data Visualization..... 2

Maps of Crime: Thematic Maps.....2
The Statistical Map..... 3
The Dot Distribution Map..... 4
The Choropleth Map..... 4
The Statistical Surface Map..... 5
The Raster and Isoline Maps..... 5
The Linear Map..... 6

Mapping Data from the JJIS.....7
Geocoding Address Data..... 7
Collecting and Preparing Data According to Useful Criteria..... 7
Selecting Map Themes and Types.....8
Aggregating Data Using Spatial Units..... 8
Creating Derivative Measures.....10
Designing the Maps..... 10

Crime Mapping Applications for Criminal Justice in Hawai`i.....11
Law Enforcement Use of GIS..... 11
Policymakers' and Community Organizations' Use of GIS..... 12

Section 2: Mapping Data in the Juvenile Justice Information System.....13

Maps of Oahu..... 15
Juvenile Offense Locations..... 15
Statistical Maps and Summary Tables by Judicial District..... 16
Maps Using GIS-Enabled Data..... 18
Selected Maps and Tables..... 19

Maps of Waipahu..... 59
Offense Locations Comparing Waipahu and Non-Waipahu Juveniles..... 60
Offense Locations for Waipahu Juveniles..... 60
Selected Maps and Tables..... 63

Appendix: Crime Mapping Resources..... 85

List of Tables

Table 1: Data Fields Extracted from JJIS..... 14

Table 2: Additional Data Types and Sources..... 14

Table 3: Juvenile Arrestees by Age and Gender, Age 13-17..... 49

Table 4: Juvenile Offense Time, Age 13-17..... 49

Table 5: Juvenile Arrestees by Primary Ethnicity, Age 13-17..... 50

Table 6: Juvenile Offense Type, Age 13-17..... 50

Table 7: Status Offense Type, Age 13-17..... 51

Table 8: Juvenile Arrestees and Offenses Per Capita..... 51

Table 9: Juvenile Offenses within .25 Mile of Public High Schools, Age 13-17..... 56

Table 10: Juvenile Offenders Per Capita in Waipahu and Oahu by Gender..... 59

Table 11: Offenses Inside and Outside of Waipahu for Waipahu Juveniles and Non-Waipahu Juveniles..... 76

Table 12: Offenses Inside and Outside of Waipahu for Waipahu Juveniles and Non-Waipahu Juveniles by Gender..... 76

Table 13: Offenses for Waipahu Juveniles by Type and Age..... 77

Table 14: Waipahu Juvenile Arrestees by Age..... 77

Table 15: Waipahu Juvenile Arrestees by Primary Ethnicity..... 78

Table 16: Offenses for Waipahu Juveniles by Type and Primary Ethnicity..... 78

Table 17: Offenses for Waipahu Juveniles by Type and Gender..... 79

Table 18: Waipahu Juvenile Arrestees by Gender..... 79

Table 19: Status Offenses Inside and Outside of Waipahu for Waipahu Juveniles and Non-Waipahu Juveniles..... 80

Table 20: Status Offenses for Waipahu Juveniles by Age..... 80

Table 21: Status Offenses for Waipahu Juveniles by Gender..... 80

Table 22: Status Offenses for Waipahu Juveniles by Primary Ethnicity..... 81

Table 23: Truancy Offenses for Waipahu Juveniles within .25 and .5 Mile of Public Schools..... 81

Table 24: Repeat Offenses Inside and Outside of Waipahu for Waipahu Juveniles and Non-Waipahu Juveniles..... 82

Table 25: Repeat Offenses for Waipahu Juveniles by Age..... 82

Table 26: Waipahu Juvenile Repeat Offender by Age..... 83

Table 27: Repeat Offenses for Waipahu Juveniles by Gender…… 83
Table 28: Repeat Offenses for Waipahu Juveniles by Primary Ethnicity……..…. 84
Table 29: Drug Offenses for Waipahu Juveniles by Age…….…….. 84
Table 30: Drug Offenses Inside and Outside of Waipahu for Waipahu Juveniles and Non-Waipahu Juveniles…….…… 85
Table 31: Drug Offenses for Waipahu Juveniles by Gender……..… 85
Table 32: Drug Offenses for Waipahu Juveniles by Primary Ethnicity…… 85

List of Figures

Figure 1: Statistical Map…….……... 3
Figure 2: Dot Distribution Map…….…… 4
Figure 3: Choropleth Map……4
Figure 4: Raster Map……..…5
Figure 5: Linear Map…….. 6
Figure 6: Judicial District Boundaries…….. 8
Figure 7: Neighborhood Board Boundaries……...9
Figure 8: Juvenile Crime Rates by Judicial District…… 10

List of Maps

Map 1: Juvenile Offense Locations…… 19
Map 2: Inset A: Juvenile Offense Location Hot Spots……..20
Map 3: Juvenile Offense Hot Spots on Aerial Photograph…….....21
Map 4: Juvenile Offense Location Density……22
Map 5: Inset A: Juvenile Offense Location Density……..23
Map 6: Juvenile Offense Locations for Males……24
Map 7: Juvenile Offense Locations for Females……...25
Map 8: Native Hawaiian Juvenile Arrestee Residences…….. 26
Map 9: Filipino Juvenile Arrestee Residences…….. 27
Map 10: Caucasian Juvenile Arrestee Residences…… 28
Map 11: Samoan Juvenile Arrestee Residences…… 29
Map 12: Japanese Juvenile Arrestee Residences…….. 30
Map 13: “Other” Juvenile Arrestee Residences…….. 31
Map 14: Juvenile Arrestee Residences by Age…….. 32
Map 15: Juvenile Offense Time…….. 33
Map 16: Juvenile Violent Offense Locations……34
Map 17: Juvenile Property Offense Locations…… 35
Map 18: Juvenile Drug Offense Locations……36
Map 19: “Other” Juvenile Offense Locations……37
Map 20: Status Offense Locations…… 38
Map 21: Status Offense Locations (Excluding Runaway)…… 39
Map 22: Runaway Locations by Gender…….. 40
Map 23: Juvenile Arrestee Age……..41
Map 24: Juvenile Arrestee Gender……42
Map 25: Juvenile Offense Time…….. 43
Map 26: Juvenile Arrestee Ethnicity……..44
Map 27: Juvenile Offense Type…….. 45
Map 28: Juvenile Offense Type (Excluding Status Offenses)…….. 46
Map 29: Status Offense Type…… 47

Map 30: Status Offense Type (Excluding Runaway)……..48
Map 31: Juvenile Arrestees Per Capita……52
Map 32: Juvenile Offenses Per Capita……..53
Map 33: Average Number of Offenses Per Arrestee……..54
Map 34: Juvenile Offense Locations within .25 Mile of Public High Schools……..55
Map 35: Juvenile Offense Locations within .5 Mile of Establishments with Liquor Licenses...57
Map 36: Offense Locations for One Juvenile……...58
Map 37: Offense Locations by Type for Waipahu Juveniles and Non-Waipahu Juveniles…..63
Map 38: Offense Locations for Waipahu Juveniles and Non-Waipahu Juveniles…… 64
Map 39: Offense Locations for Waipahu Juveniles and Non-Waipahu Juveniles by Offense Type (excluding status offenses) over Land Uses……..65
Map 40: Offense Locations for Waipahu Juveniles and Non-Waipahu Juveniles by Offense Type over Poverty…… 65
Map 41: Offense Locations for Waipahu Juveniles and Non-Waipahu Juveniles by Offense Type (including status offenses) over Ethnic Concentration……... 66
Map 42: Offense Locations for Waipahu Juveniles and Non-Waipahu Juveniles by Offense Type (excluding status offenses) over Ethnic Concentration……. 66
Map 43: Offense Locations for Waipahu Juveniles by Age…….. 67
Map 44: Offense Locations for Waipahu Juveniles by Age…….. 68
Map 45: Offense Locations for Waipahu Juveniles by Primary Ethnicity…… 68
Map 46: Offense Locations for Waipahu Juveniles by Gender……69
Map 47: Offense Locations for Waipahu Male Juveniles by Offense Type…… 70
Map 48: Offense Locations for Waipahu Female Juveniles by Offense Type……70
Map 49: Runaway Offense Locations for Waipahu Juveniles……...71
Map 50: Approximate Locations for Waipahu Juvenile Runaway Offender's Residence and Offense Locations……72
Map 51: Truancy Offense Locations for Waipahu Juveniles……72
Map 52: Offense Locations for Repeat Offenders Residing in Waipahu…….. 73
Map 53: Offense Locations for Waipahu Juvenile Repeat Offenders ……74
Map 54: Drug Offense Locations for Waipahu Juveniles……...74
Map 55: Youth-Related Resources in Waipahu by Type…….. 75

Crime Mapping Applications for Hawai`i's Juvenile Justice Information System

Introduction

Juvenile crime is not randomly distributed across the geographic landscape, but tends to exhibit some spatial pattern. Understanding this spatial pattern is useful for any community or agency attempting to address the problem. In the past, police departments used "pin maps" to visualize the location of crime incidents and observe any patterns that might appear. With geographic information systems (GIS) technology, this pin mapping process is automated digitally. And various types of spatial analyses can be conducted based on available data along with additional data generated by sophisticated GIS software programs. GIS is a computer-based approach to interpreting maps and images and applying spatial analytic techniques to a host of problem solving activities, from service delivery to crime control. It is useful for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data that have a spatial or geographic component.

Many government agencies, including law enforcement and human services organizations, are using GIS technology for a wide variety of purposes. Applications of GIS technology in law enforcement and social programs include providing spatial information and assessments for the allocation of resources, identification of crime "hot spots," evaluation of program effectiveness, criminal investigations, locating service delivery sites, and developing location-specific delinquency prevention and youth intervention programs. GIS can be a useful technology throughout the entire cycle of planning and policy making, including needs and assets assessments, program and policy design, resource allocation, evaluation, and research.

Currently, the application of GIS technology among justice and related agencies in Hawai`i is fairly limited. The lack of utilization of GIS technologies hampers the ability of the state to improve analyses and problem-solving relative to other states that have been able to take greater advantage of this technological innovation.

This study was conducted to identify the potential applications of GIS for law enforcement and youth agencies in Hawai`i and to generate a set of reference maps and tables using data contained in the Juvenile Justice Information System (JJIS). The JJIS is a comprehensive statewide information system that combines juvenile justice information from the police departments, prosecutors, Family Court, and Hawai`i Youth Correctional Facility (HYCF). This information system allows participating agencies to track juvenile offenders and contains hundreds of fields of information, including address information. The three main objectives of the project can be summarized as follows:

1. To map Juvenile Justice Information System data using geographic information systems technology;
2. To identify the relevant applications of GIS for law enforcement and human services agencies;
3. To educate potential users of the capabilities of GIS in the field of criminal justice and youth services.

The report is organized in two major sections. Section 1 proceeds with an introduction to crime mapping and a description of the potential applications of GIS using the JJIS. Section 2 presents maps and tables that were generated using GIS technology. They are divided into two sets. The first contains maps and tables for the island of Oahu and the second includes maps and tables of Waipahu as an example of neighborhood-level crime mapping.

Section 1: Crime Mapping and Its Potential Applications in Hawai`i

Mapping as a case of data visualization

Maps help us to visualize data about places. Like pictures worth a thousand words, maps represent a pictorial illustration of spatial information. GIS technology enables one to organize and analyze data containing geographic information such as addresses or other geographic coordinates such as latitudes and longitudes. These data are mapped and presented in visual form. Geographic data can be analyzed using a variety of spatial statistical methods. Spatial analyses allow policymakers, administrators, and practitioners to understand the geographical scope and characteristics of a problem or phenomenon. This spatial dimension greatly enhances the capacity of institutions to understand and effectively address critical social problems.

GIS maps are not simply graphical images, but the outcome of scientific activities, including hypothesis formulation, data gathering, analysis, review and evaluation. Although desktop mapping has made the process easier, crime mapping still requires considerable care and effort. Technicians need to determine how specific data can be graphically represented to communicate the desired information, and which techniques to use given the nature of their inquiry. Constructing maps that reflect the data in the most effective way becomes a melding of science and art. If crime maps are done well, they can convey important findings at a simple glance.

GIS technology can process many types of spatial data, including location, distance and direction. Mapping software can plot locations represented by "points" on a map at a specific site. Locations may also be displayed by "polygons" that outline a physical area, such as a park or building. GIS software can measure and analyze distances, or the proximity between two or more points. Measurements can be taken using either straight lines or designated transportation routes. Software programs can also analyze directions through charting the geographic movement of phenomena over time. For example, the incidence of burglaries may shift in direction from north to south over the course of the year.

Maps of Crime: Thematic maps

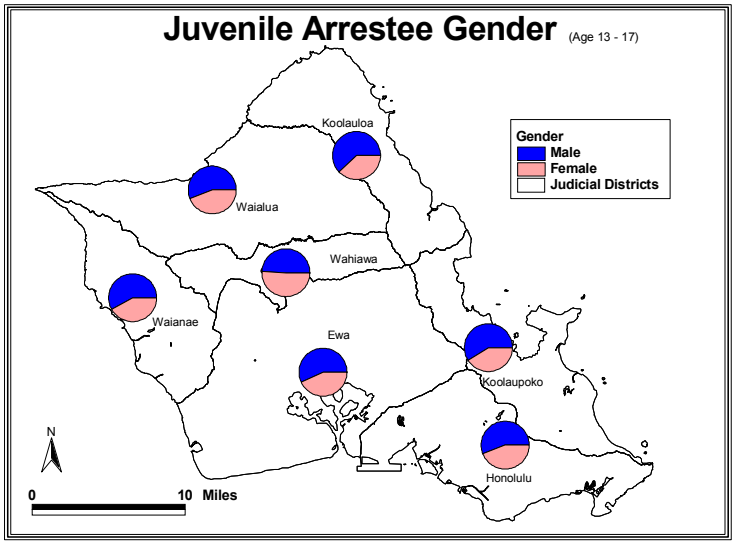
Crime maps are typically thematic maps; they are composed of multiple layers containing data that allow analysts to juxtapose different types of information. In simpler terms, the location of crime incidents are juxtaposed to various features of the physical and social environment, such as the concentration of poverty or the pattern of land use, so that one can analyze the spatial relationships between crime and place.

There are six basic types of thematic maps: statistical maps, dot distribution maps, choropleth maps, statistical surface maps, raster and isoline maps, and linear maps. Statistical maps contain proportional symbols such as pie or bar charts or histograms to aid in visualizing the quantitative data. These graphics are usually placed within a geographic boundary such as a patrol beat, neighborhood, census tract or political jurisdiction. The most frequently used thematic map in police work is the dot distribution map, or more commonly known as the "pin map." These maps use numerical data to show the location of specific events. Choropleth maps are used for visual area comparisons by using boundaries such as precincts, districts, and counties to show variations in values. Isoline maps unify points of equal value using lines to separate areas into discrete value ranges, like those used in topographical maps. Many statistical surface maps are also isoline maps with an added third dimension to the illustration. The result is a three dimensional portrayal based on varying values within each grid or pair of isolines. Where crime rates are high, the surface height will be raised to reflect the high crime rate. Linear maps can be used to show streets and highways as well as flow directions and proportionality. Linear maps can be used as base maps to give the reader a sense of location. In crime analysis, the most common application beyond the base map is to show directional and proximal relationships between at least two events, for instance, auto theft and vehicle recovery.

The issue the GIS technician needs to contemplate is the selection of the most appropriate type of map to illustrate a particular pattern or social phenomena given the type and reliability of data available. Maps contained in this section were created using data from the JJIS and are displayed in larger format in the second section of this report.

The Statistical Map

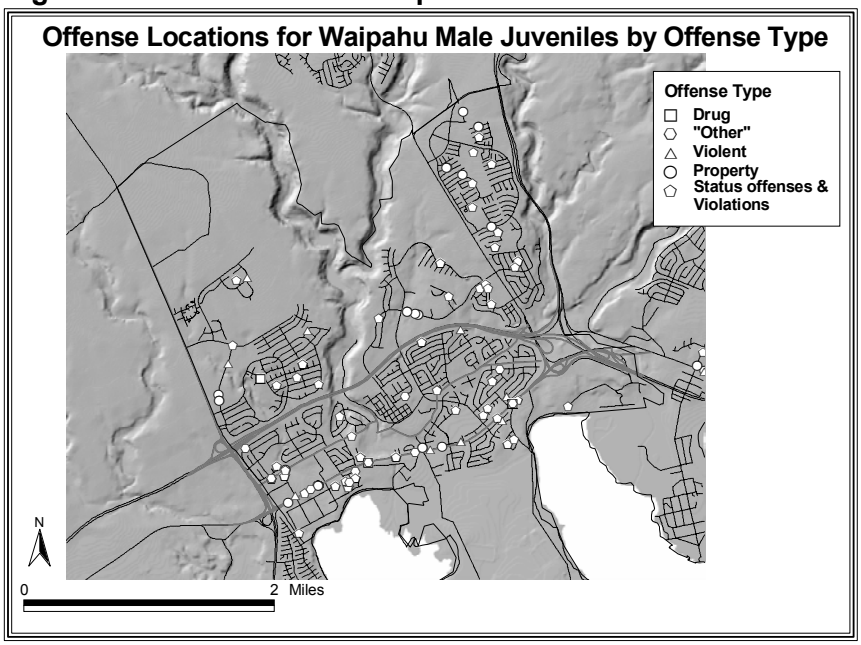
Figure 1: Statistical Map



Statistical maps summarize quantitative data and display them on maps so that readers can make statistical comparisons between different places. The origins of the statistical map lie in handwriting raw numbers into geographically defined boundaries or subdivisions such as neighborhoods or patrol beats. Common statistical symbols include pie charts, bar charts, graduated circles, or dots that are color coded to numerical values, such as incident counts. Multiple variables can be included in the charts, such as poverty level alongside crime rates or gender alongside ethnicity. The main advantage of the statistical map is that it places the data in a well-defined geographic context. Map design must take into account the final size of the map and the scale to be used, as the biggest disadvantage of the statistical map is that symbols such as pie charts may overlap into bordering areas. Figure 1 is a statistical map that uses pie charts to compare the proportion of males and females arrested in each of the seven judicial districts on Oahu.

The Dot Distribution Map

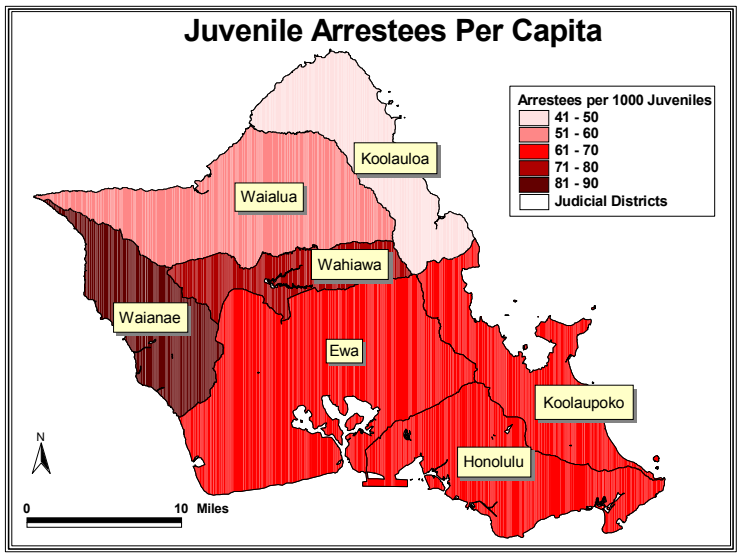
Figure 2: Dot Distribution Map



Dot distribution maps or "pin maps" chart specific point locations and are one of the most commonly used maps in crime mapping. Pin maps are created from "point files," which are database files containing at least two pieces of information: a descriptor of the event and locational data, such as street addresses or geographic coordinates. Point patterns can be classified into four general categories: random, uniform, clustered or dispersed. The spatial pattern of point data is extremely useful in analyzing or describing a crime profile or pattern. Points can be color coded or represented as icons to distinguish different types of events. Figure 2 is a pin map that charts the location of incidents for which a juvenile was arrested. The different icons represent different types of crime.

The Choropleth Map

Figure 3: Choropleth Map



Choropleth maps use shades or colors to reflect the density of the mapped phenomenon or to symbolize classes within it. Symbols, shades and colors are varied, with each variation representing a discrete range of values. Choropleth maps can be used to show differences in absolute numbers between geographic areas such as the numbers of arrests in a set of neighborhoods or used to display normalized values, such as the per capita rate of crime in a set of neighborhoods. Figure 3 displays juvenile arrest rates on Oahu, normalizing the number of juvenile arrests by the number of juveniles in each of the judicial districts. Darker shades represent higher per capita arrest rates while lighter shades represent lower rates.

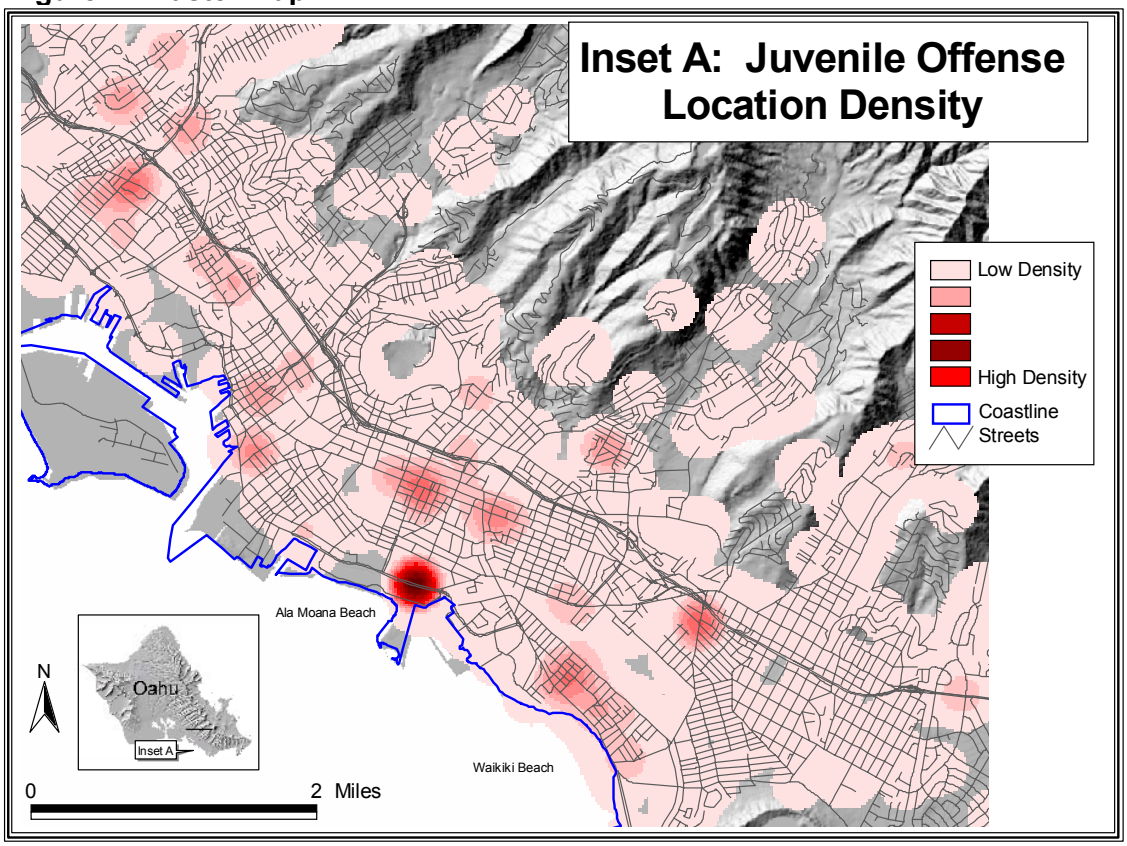
The Statistical Surface Map

Surface maps are similar to the choropleth map, but the difference is that these maps display a three-dimensional illustration of the numerical values. These maps often give a dramatic look to quantitative information, using small grids to parse data and elevate the surface of the geography to show variations in values. The surface map has the ability to better visualize flow patterns or directions within the data. The disadvantage arises when the elevation coordinates are added to give the map a three dimensional effect, potentially hiding landmarks, boundaries or other features behind "peak" areas in static maps. In the interactive use of GIS, many software programs have the ability to rotate maps and control the vantage points from which the landscape is viewed.

The Raster and Isoline Maps

When examined closely, raster maps appear as rows of pixels, with each cell shaded or colored to represent a range of values. Cells that share the same values are the same color or shade. In crime mapping, raster maps often display the location of hot spots or "high density" crime areas. Isoline maps are very similar, but instead of using shades or colors in pixels, lines are drawn along areas of equal values. Isoline maps are often used to show ocean depth or mountain topography, but can also be used to differentiate crime density levels across the geography. Figure 4 is a raster map that shows the relative density of incidents for which juvenile arrests were made. Darker shades represent areas of high density while lighter shades cover areas of lower density.

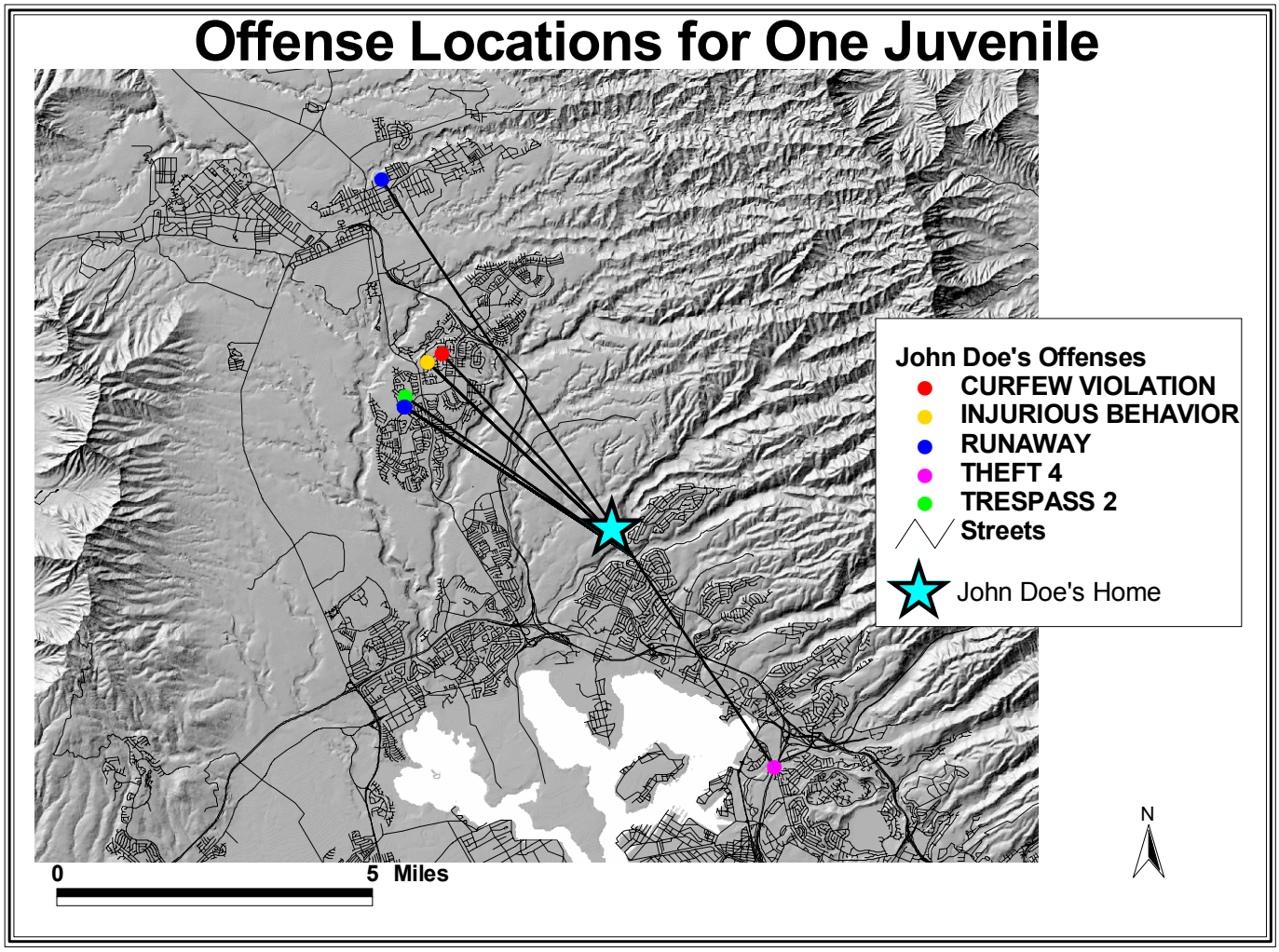
Figure 4: Raster Map



The Linear Map

Linear maps utilize lines that flow between two or more points. The thickness and colors of the lines can vary to reflect different values contained in the database file. A typical example of a linear file is a street map where streets vary in thickness based on their relative width or traffic volume. In crime mapping, lines or routes can be drawn and distances calculated to analyze the proximity or frequency of events between two locations, such as the residence of victims and offenders. Figure 5 displays the relative proximity between the home of a fictitious juvenile arrestee and the location of the incidents for which that juvenile was arrested.

Figure 5: Linear Map



Mapping Data from the JJIS

There were six steps involved in mapping data from the JJIS. They included: geocoding address data; collecting and preparing data according to useful criteria; selecting map themes and types; aggregating data using jurisdictional boundaries; creating derivative measures; and designing the maps.

Geocoding address data

Geocoding, a process of geographically referencing locational data such as addresses to a particular point on the Earth's surface, was the first step in the mapping process. The JJIS data includes two address fields: locations where incidents occurred and residences of the arrested juveniles. Each record includes many fields of data such as type of crime, date of birth, ethnicities, gender, disposition after arrest, and school, to name a few. Records that link address data to qualitative and quantitative data regarding each incident and arrestee allows analysts to chart the characteristics of crimes and arrested juveniles within the physical and social geography of a place.

There are two common methods for geographic referencing. The most accurate method uses a global positioning system, or GPS. Some law enforcement agencies use GPS units to determine the exact location of a crime with the push of a button. GPS units use x-y-z coordinates based on satellites in space in order to locate one's exact position. A second method uses locational data such as addresses and proceeds to reference these data to an existing geo-referenced file. In this case, addresses contained in the JJIS were matched to corresponding digital street maps maintained by the City and County of Honolulu (C&C). Utilizing a geocoding extension and an automated process, the GIS software matched addresses to points on the map. Further data cleaning was necessary and manual geocoding was completed for the remaining addresses.

It is important to note that there are several potential sources of error in the mapping process using address data, including the accuracy of the data as well as the accuracy of the geocoding. Incomplete or misspelled addresses, incomplete street files, or imprecise placement of dots due to large parcel sizes (such as malls) may contribute to the inaccurate placement of points. For example, the JJIS data revealed numerous incidents at large shopping centers, but address matching capabilities and data did not allow an identification of which part of a mall an incident occurred in.

Collecting and preparing data according to useful criteria

Extracting relevant data from large databases such as the JJIS requires careful thinking about what it is that one wants to know. For the purposes of this initial demonstration project, a limited number of data fields were selected, including incident locations, juvenile addresses, offense type, gender, ethnicity, and date of birth. These allowed the creation of a set of reference maps that display commonly queried characteristics describing crimes and arrestees. Section two details the types of data fields used for this project.

In addition, other sources of data were added to the GIS, including U.S. Census data, land use data, land parcel maps, aerial photographs, a community resource directory, topographical maps, street and highway files, and judicial district and neighborhood board boundaries.

Selecting map themes and types

Querying the data - Once relevant data are assembled, they can be queried using GIS software. Filtering or querying data in a GIS provides a simple way to answer specific questions related to place by selecting desired fields along with data ranges. For example, simple queries can answer the questions: Where are the offenses for which police officers are making arrests during the night shift? Where do females arrested for runaway offenses live? What types of crime are taking place near schools? Are there higher rates of crime near liquor outlets? How many teen drug arrests are there in each judicial district? By performing queries, new tables and corresponding maps could be created that allow the exploration of these spatial patterns and relationships.

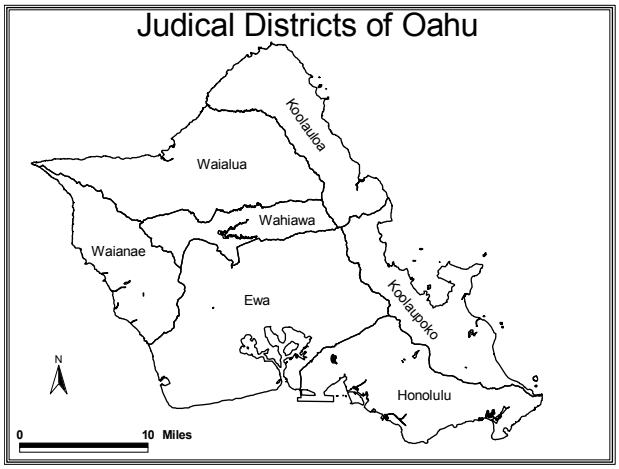
Selecting geographic units of analysis - One can specify any spatial unit (such as county, census tract, police beat, or school district) for analysis. The three geographic units used for this project include the boundaries of the City and County of Honolulu, along with judicial districts and neighborhood boards within it. Spatial units also include radii around liquor stores and public schools. Digital files for select boundaries were downloaded from the state government web site. Currently, the web site includes over 125 data layers publicly available for download. When digital boundary files are not available, they can be digitized from paper maps or created by manipulating existing files. For example, judicial districts were redrawn for this project using census block group boundaries updated in the 2000 Decennial Census. This enabled the calculation of crime rates using demographic data from the 2000 U.S. Census.

Selecting and juxtaposing map themes - A theme is a map layer containing related geographic features, such as roads and highways or schools and parks. By layering different themes, one can explore spatial patterns and relationships. The selection of themes is based on the question that is posed. For example, if one wanted to know how close arrestees live to specific types of social services agencies, one would create a juvenile residence theme and juxtapose it with a theme based on a query of social services agency location data, placing one layer upon the other. Multiple layers can be juxtaposed and various spatial analyses can be conducted.

Aggregating data using spatial units

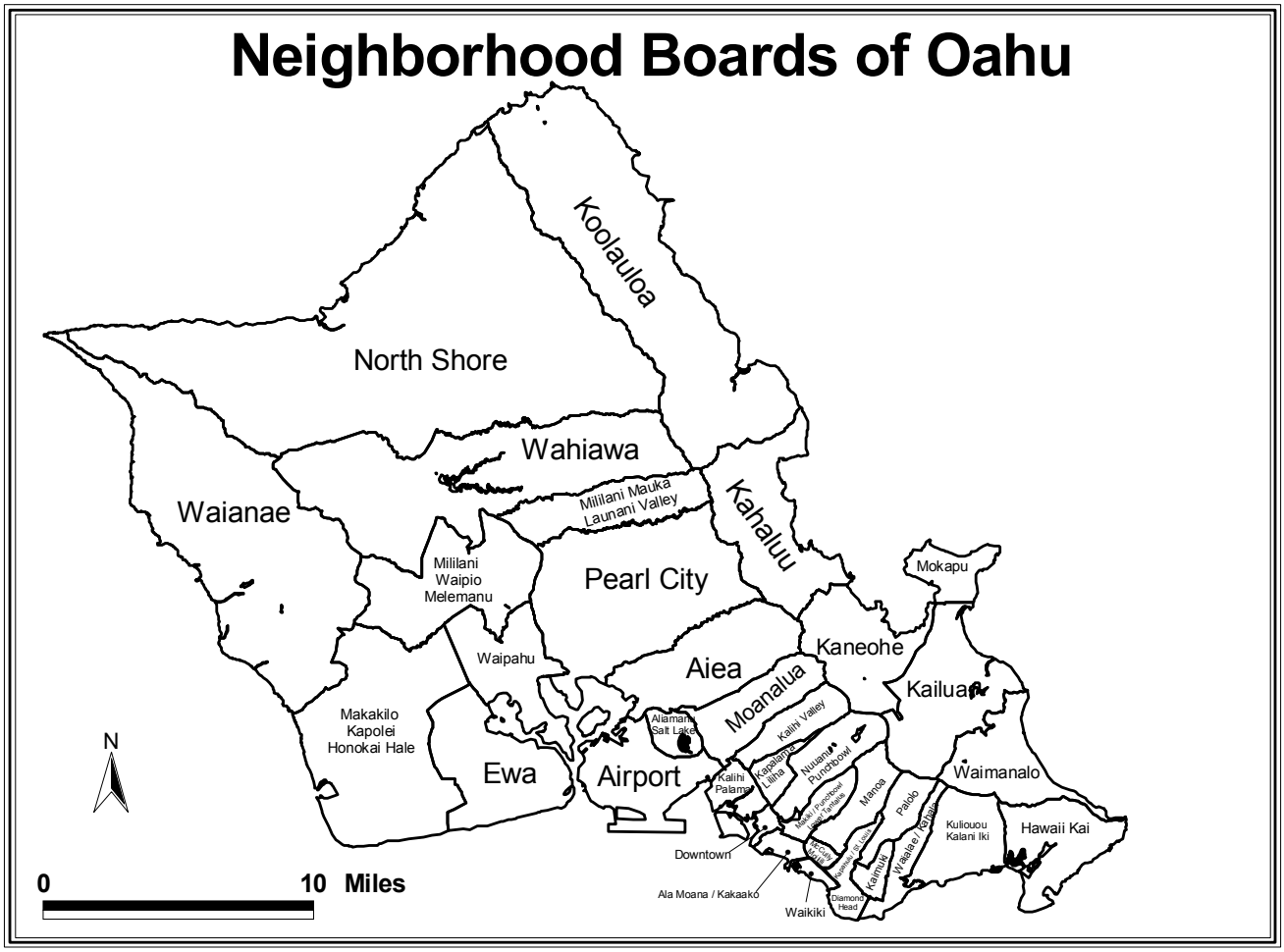
GIS is a very useful tool to aggregate data according to selected spatial units or boundaries, such as judicial districts, school districts or neighborhood boards. By using spatial units to aggregate points on a map, one can parse any database spatially, that is, by the location of points within designated boundaries. In this report, judicial district boundaries were used to aggregate data for inter-district comparisons. Figure 6 displays the judicial district boundaries.

Figure 6: Judicial District Boundaries



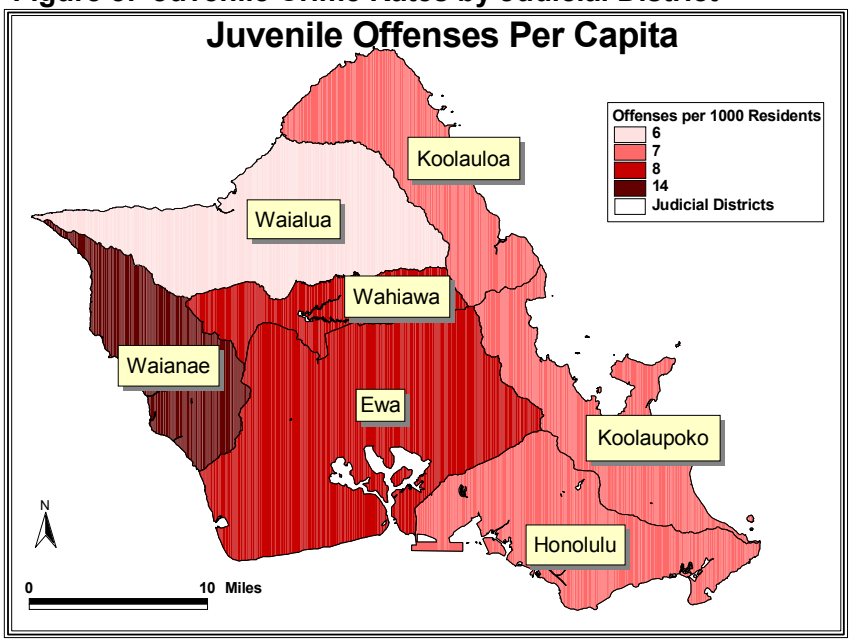
Neighborhood board boundaries were used to isolate records for one of the neighborhoods for case study purposes. These boundaries were also used to parse and aggregate census data. This function is extremely helpful in cases in which a database may not contain jurisdictional information, though counts or comparisons by jurisdictional boundaries are important, which is oftentimes the case. Figure 7 displays the neighborhood board boundaries on Oahu.

Figure 7: Neighborhood Board Boundaries



Creating derivative measures

Figure 8: Juvenile Crime Rates by Judicial District



There are many different types of spatial measures that can be derived from existing databases using GIS capabilities. Some common types of spatial measures include densities, distances and rates. Crime mapping analysts use various statistics, such as Ripley's K, to measure the *density* of crimes within a locale. *Distances* between points, such as the location of crime incidents and residences of offenders, can be measured and then used in statistical calculations. One can, for example, understand which categories of youth tend to travel further distances to commit certain types of crimes. *Rates* of crime can be derived by using GIS software to aggregate data along selected geographic boundaries. For example, GIS was used to aggregate demographic data from the US Census and arrest records from the JJIS in order to calculate the per capita rate of crime across judicial districts. Figure 8 shows the crime rates among teens for each judicial district. Additionally, themes can be juxtaposed to perform new counts, such as the number of drug incidents within a 500-foot buffer of each of the schools.

Designing the maps

Maps have six basic elements in their design, including the themes, title, legend, scale, orientation and source. The themes display the selected physical features like roads and social attributes like crimes overlaid upon the geography. Titles of maps describe their contents. Legends provide the meaning of various symbols, shades, polygons and lines that are included on a map, such as streets, incident locations, crime types, and census tracts. Different combinations of icons and colors are used to distinguish physical landmarks, such as schools and government services, to distinguish the characteristics of a phenomena such as the age of a juvenile, or to distinguish features of the landscape such as the income level within a neighborhood. Scale refers to the equivalencies between the map measurement and the actual measurement of the location. One inch on a map may represent one mile on the ground. The orientation of a map references its placement on a page to its global direction—north, south, east and west. The source refers to the originator of data used to create the major map themes.

Crime mapping applications for criminal justice in Hawai`i

This section briefly describes some of the potential applications of crime mapping using the JJIS. Many of these applications would apply to other sources of criminal justice data as well. These applications are described for various types of agencies, including police departments, courts and corrections, policy makers and community organizations.

Law enforcement use of GIS

Use of GIS in police departments has proliferated over the past decade. Nearly one-third of the 19,000 police agencies in the U.S. have invested in crime mapping systems. There is wide variation in the degree to which GIS is used in daily operations and the level of sophistication and integration of crime mapping systems within departments. Some police departments equip their patrol officers with global positioning system (GPS) units to mark the exact location of crimes, to document the location of evidence, or to track the movement of suspects. Sophisticated systems send coordinates and crime information to a central database where crime maps can be viewed in "real time." Some departments use intranet or password-protected internet networks to share frequently updated maps with other agencies or agency personnel. Some systems allow networked users to query the database to create maps for their specialized needs.

Crime mapping capabilities are useful for police officers patrolling neighborhoods and investigators trying to solve cases. They can view the recent crime pattern of a neighborhood and query a GIS to search for particular types of crime patterns, such as the location of all recent burglaries within a mile radius of a given intersection. With the use of relational databases, they might also view a map plotting past incidents for which a particular suspect was arrested. Points on a map can also be hyperlinked to archived photos. With dot density and raster maps, police officers may be able to visualize crime spree patterns in a certain patrol beat. Time series maps can be animated as a moving picture capturing the shifts in crime patterns over the course of a month or year. Some investigators have used GIS to prepare trial evidence.

Crime mapping has proven useful for law enforcement managers. Some police departments map incoming calls for service. Dot density and choropleth maps can indicate the relative frequency of calls in different patrol beats. GIS can be programmed to assign different weights to different types of calls, as some calls require more time and resources than others. This can be useful in efficiently allocating limited resources. Mapping "hot spots" as they arise can also lead to a more timely reallocation of personnel. GIS can also be used to explore questions of displacement resulting from changes in agency activities. Displacement can be examined along many dimensions, including changes in the times crimes are committed, changes in victim and offender characteristics, changes in crime tactics, and changes in types of crimes committed in a given area.

Similarly, probation and parole agencies can use GIS for resource allocation. GIS software can be used to assess caseloads, allocating responsibilities according to offense type, offender characteristics, and the proximity of residences. In some states, GPS units are used to track the movement of clients or those under house arrest. Courts can also use GIS to track the disposition of offenders according to their residential location. This may help identify neighborhoods in greater need of support or supervisory services.

Crime mapping can also assist in tailoring collaborative activities to neighborhood-specific needs. For instance, different units or departments assess priorities differently, whether curbing domestic violence, weapons proliferation, truancy, or auto thefts. Understanding the spatial pattern of each crime type for specific neighborhoods can help to build broader consensus as to priorities in a given locale.

Policymakers' and community organizations' use of GIS

There are many useful applications of GIS for policymakers and community organizations utilizing JJIS and other justice data. Two major areas are strategic planning and policy design. A growing number of community and interagency collaborations are using GIS to strategize and coordinate the work of community organizations, social service agencies, and law enforcement organizations. Interactive GIS has proven to be a useful tool in the planning process to assess needs, identify resources, set priorities and design action plans. The maps for the Waipahu neighborhood board featured in the following section were generated through a community planning effort to develop a response plan to address youth violence in Waipahu, a collaborative process sponsored by the City and County of Honolulu. JJIS data were utilized by the Asian Pacific Islander Youth Violence Prevention Center (API Center), which provided technical assistance to the planning effort. Following an interactive query process, members of the collaborative identified a variety of maps that were helpful to them in gaining a fuller understanding of youth problems in the neighborhood. Maps and tables were subsequently used for strategic planning and in grant applications to address identified problems.

Policymakers can integrate criminal and juvenile justice data with data from a wide range of agencies, such as the Departments of Health, Education, and Human Services, to better inform policy development. Public information such as school test scores, truancy records, public safety reports, and public health records may be integrated in a GIS along with criminal justice, demographic, socioeconomic, and resource data. By combining a variety of data sources in a GIS, policymakers across a wide range of departments can visualize the geographic distribution of the state's needs and resources. Policy analysts and researchers can utilize an array of methods to better understand the spatial dimension of social problems. And by so doing, decision-makers can make more informed policy choices.

GIS can also facilitate community and interagency collaborations, as it can be used as a tool for the collective visualization of problems. By bringing together many sources of data to clarify problems, knowledgeable "experts," both lay and professional, can share information and come to understand the nature of problems from multiple vantage points. Understanding the variables impacting social problems, such as underlying changes in the demographic composition of communities or geographic gaps in the continuum of services, can enrich cooperative partnerships. Mapping technologies can be used to share data between agencies and communities, leveling the information playing field and facilitating constructive dialogue grounded in the particularities of place.

In sum, GIS applications lend themselves to all phases of the planning and policy process across a wide range of organizations. GIS technology adds an important spatial dimension to the analysis of social problems, thus aiding in the research and investigation of crime and related social

problems. Policy analysts and managers can use GIS to design more effective, efficient, and equitable policies and programs. It can be used to improve implementation and resource allocation, and can provide useful spatial information for policy and program evaluation. Finally, GIS can be used as a technology to collect and share data containing spatial information. The next section provides a glimpse of the types of information that can be conveyed by applying mapping techniques to data contained in the JJIS. It also previews the types of maps that can inform the various activities above.

Mapping Data in the Juvenile Justice Information System

The Juvenile Justice Information System (JJIS) is an information networking system designed to track juveniles through various stages of the juvenile justice process, beginning at the point of arrest. The system is administered by the State of Hawai`i, Department of the Attorney General and coordinated among a consortium of agencies through the Juvenile Justice Information Committee (JJIC). The system is based on a relational database that integrates data from a variety of sources, including police departments, prosecutors, Family Court, and the Hawai`i Youth Correctional Facility (HYCF). Information in the JJIS includes juveniles' first exposure to the justice system and extends through prosecution, adjudication, and incarceration. The JJIS provides information on each juvenile arrested, including offense and court data, personal data, and services provided. The database also includes fields for a variety of notations, such as those concerning suicide risk, gang affiliation, and substance abuse.

The JJIS was designed to enable juvenile justice agency staff to track juvenile offenders through the justice system. It also helps participating agencies to determine the best programs and treatment for juvenile offenders. While the system can provide data to assess the usefulness of treatment alternatives, it can also be used to determine resource needs, evaluate programs and their effectiveness, and assist in developing policy recommendations. The JJIS was also designed for use by researchers in order to study issues related to improving and enhancing juvenile crime policy. Building on the experience with the implementation of the JJIS, the Department of the Attorney General anticipates a successful integration with other related agencies. Thus, the following maps were designed with these considerations in mind. Most of the maps could as easily be created using criminal justice data for the adult population.

This section provides a sample of the types of maps that can be created using data in the JJIS. Data were for arrests made in 2001. Many of the maps are accompanied by tables that contain the numeric values that are represented in the associated maps. The maps are prefaced by a brief narrative description and an explanation of the procedures when appropriate.

For the purposes of this demonstration project, only select fields of data were used. The main categories of information included: location of offense, home address of arrestee, offense time, type of offense, and juvenile characteristics, including age, gender, and ethnicity. Table 1 lists the data fields filtered from the JJIS for this project and a description of each field.

Table 1:
Data fields extracted from JJIS

Description of Data	*JJIS Data Field*
Location of Offense	OFFENSE_LOCATION
Address of Juvenile	STREET_ADDR
OffenseType	CHG_NBR_FK
Offense Time	OFFENSE_TIME
Age	DATE_OF_BIRTH
Gender	SEX_CODE
Ethnicity	ETH1

In addition to JJIS data, other data files were used to create themes. Table 2 lists these additional sources.

Table 2:
Additional data types and sources

Description of Theme	*Source of Data*
Topography	Dept. of Business, Economic Development and Tourism
Aerial Photos	City and County of Honolulu
Land Use	City and County of Honolulu
Streets	City and County of Honolulu
Major Roads	City and County of Honolulu
Public Schools	City and County of Honolulu
Waipahu Community Resources	Office of Youth Services
Liquor Outlets	Department of Health
Population	U.S. Census, 2000
Ethnicity	U.S. Census, 2000
Poverty	U.S. Census, 2000

The maps are organized according to two scales: maps of Oahu and maps of Waipahu. Many of the statistical maps of Oahu use judicial district boundaries, while the maps of Waipahu use neighborhood board boundaries. The maps for Oahu include juveniles age 13-17 at the time of arrest. The maps of Waipahu include all juveniles, including a small number who were 12 or under at the time of arrest.

Maps of Oahu

Juvenile offense locations

On Oahu in 2001, there were 7,711 juvenile offenses and 4,307 arrestees, some of whom were arrested more than once during the year. After geocoding the matchable addresses of offenses and arrestees and selecting those offenses among youth between the ages of 13 to 17, a total of 6,530 offenses and 3,551 arrestee residences remained. Detailed maps of arrestee residences were omitted to protect the confidentiality of juveniles. Tables include numerical summaries of mapped data only.

The first set of maps includes the island of Oahu, which is also the jurisdiction of the City and County of Honolulu. The map, entitled **Juvenile Offense Locations**, is a dot density map showing the location of all juvenile offenses for which an arrest was made in 2001. Dots can be varied in size and color in order to distinguish characteristics within a theme. In this map, the size of dots is varied to designate "hot spots," a term referring to places where there is a relatively higher concentration of crime. As indicated in the legend, the size of the dots designates unique ranges in the number of offenses at a particular location. The smallest size dot represents 1 to 11 offenses at a single location, while the largest dot represents 208 offenses.

Inset A: Juvenile Offense Location Hot Spots is a map that zooms into the rectangular area highlighted in the previous map. In addition to offense locations, the locations of public high schools are also shown in the inset. When examining the spatial pattern of juvenile arrests among teens, it is useful to include landmarks that help to reference the location of offenses to sites that may be of significance to that population. In addition to high schools, other sites can be included, such as middle schools, parks, recreation centers, social service agencies, and other youth facilities. It is not unusual that many of the hot spots are in close proximity to schools, since schools are where youth congregate and a portion of status offenses include truancies for which students often are found near schools. The largest hot spot on this map is located at the Ala Moana Shopping Center, where 208 offenses were recorded. The exact location within the mall could not be determined with the available data.

Base maps can be changed in order to gain a different perspective of the geography or topography of the landscape. The map entitled **Juvenile Offense Hot Spots on Aerial Photograph** shows the same set of hot spots over a base map displaying an aerial photograph of the area. Labels are added to name major landmarks, in this example, the Ala Moana Shopping Center and McKinley High School.

Hot spots can also be displayed using raster maps. An example is shown in **Juvenile Offense Location Density** and **Inset A: Juvenile Offense Location Density**. Areas of high density are darkly shaded whereas areas of low density are lightly shaded.

There are many different offense and arrestee characteristics that one could display using dot density maps. The maps entitled **Juvenile Offense Locations For Males** and **Juvenile Offense Locations For Females** show the offense locations for each respective gender. Similarly, dot density maps can show the distribution of offense locations for youth of different ethnic backgrounds. Six maps were created to show the spatial distribution of the residences of juvenile

arrestees among the main ethnic groups using JJIS' "primary ethnicity" field (the first of five ethnicity fields in the JJIS). These maps are respectively titled **Native Hawaiian Juvenile Arrestee Residences; Filipino Juvenile Arrestee Residences; Caucasian Juvenile Arrestee Residences; Samoan Juvenile Arrestee Residences; Japanese Juvenile Arrestee Residences; and "Other" Juvenile Arrestee Residences**. These dot density maps are all monochromatic, that is, they use dots of the same color.

Dots in dot density maps can also be varied by color, with each unique color representing a different characteristic or value within the theme. Several color-coded maps are displayed here. The **Juvenile Arrestee Residences by Age** map shows the distribution of arrestee residences, with color-coded dots distinguishing the age of the juvenile. The **Juvenile Offense Time** map shows the location of offenses, with color-coded dots distinguishing time ranges during which an offense occurred. The same could be done by month, season, year or other time increment.

Color-coding can also be used to distinguish different types of offenses. There are over 125 different offense codes in the JJIS. For the purposes of this mapping demonstration project, offenses were organized into five major categories: violent, property, drug, "other," and status offenses. The first four non-status offense categories were further categorized according to felony, misdemeanor, and petty misdemeanor offenses. Color-coded maps were created for each of the major crime categories, respectively titled, **Juvenile Violent Offense Locations; Juvenile Property Offense Locations; Juvenile Drug Offense Locations;** and **"Other" Juvenile Offense Locations**. Each color designates the location of felony, misdemeanor, or petty misdemeanor crimes. The **Status Offense Locations** map uses color-coded dots to distinguish the different types of status offenses. Since approximately half of the status offenses were runaways, an additional map was created that omits runaways, entitled **Status Offense Locations (Excluding Runaway)**. Subcategories of crime can also be mapped, showing the spatial distribution of arrestees by select characteristics within that subcategory. For example, the **Runaway Locations by Gender** map shows the locations of runaway offenses, with color-coded dots distinguishing males and females.

Statistical maps and summary tables by judicial district

A series of eight statistical maps were made to compare offense and arrestee characteristics across judicial districts. GIS was used to aggregate data by jurisdictional boundaries. A boundary map was overlaid upon a dot density map of offenses. The line boundaries (or set of polygons) were used to "capture" those dots within each judicial district and to create subsets of tables for each. Once totals were calculated for each subset, statistical maps were created. These maps use pie charts to show the proportional distribution of values for each theme.

The **Juvenile Arrestee Age** map shows the relative proportions of juvenile arrestees by age for each judicial district. It is interesting to note that the age group comprising the greatest proportion of arrests in the Wahiawa, Ewa and Honolulu districts is age 15, while the largest age group for Koolauloa and Koolaupoko on the windward and northern sides is 17. For Waianae and Waialua, the largest age group among arrestees is age 16. There are several explanations for these differences. One might be a lower rate of crime among younger juveniles on the windward and northern sides as compared to other areas. A second may be that youth on the southern and leeward sides are cycling out of the juvenile justice system as they reach their late teens. Another

may be a movement to the leeward side of juveniles in their late teens who are at risk of arrest. A fourth explanation may be a difference in policing practices on the windward and northern sides that lead to lower arrest rates for certain types of crimes for which younger teens tend to be arrested. Statistical maps that visually place quantitative values into their geographic context can evoke associations or hypotheses that simple tables may not be as conducive for.

Statistical maps using pie charts were also created to show the proportional distribution of arrestees by gender, ethnicity, offense time, and offense type. The **Juvenile Arrestee Gender** map shows the proportion of male and female arrestees for each judicial district. The Wahiawa district is the only one in which female arrestees outnumber males. The lowest proportion of females can be found in the Koolauloa district. The **Juvenile Offense Time** map shows the proportional distribution of offenses across time increments during the 24-hour period of a day.

The **Juvenile Arrestee Ethnicity** map shows the relative proportions of arrestees by ethnic background, using the first of five ethnicity fields contained in the JJIS. The ethnic identification is collected from the juvenile by the police departments at the time of arrest. Further calculations can be done to count all five ethnicity fields in determining the ethnic distribution of arrestees. Calculations can also be performed to normalize the ethnic counts as their percentage of the ethnic population in each district using data from the U.S. Census, though not all ethnic categories in the Census neatly correspond to those in the JJIS.

There are four separate statistical maps that compare the relative proportion of juvenile offenses by offense type. The first of these, entitled **Juvenile Offense Type**, shows the relative proportion of different types of offenses that include the following: drug, violent, property, status, and "other" offenses. Since status offenses account for over one-half to nearly two-thirds of all offenses in the various judicial districts, a similar map was made that omits status offenses, entitled **Juvenile Offense Type (Excluding Status Offenses)**. A separate map was made for status offenses alone, entitled **Status Offense Type**. The various sub-categories of status offenses are color-coded and include the following: beyond parental control, curfew violation, injurious behavior, runaway, and truancy. Since runaways account for such a large proportion of all status offenses (70 to 94 percent across the judicial districts), an additional map was created that excludes runaways, entitled **Status Offense Type (Excluding Runaway)**.

Immediately following this set of statistical maps are corresponding tables that show the numerical values that were aggregated for each judicial district and used to create map themes. The titles of these tables are as follows:

- Table 3: Juvenile arrestees by age and gender, Age 13-17
- Table 4: Juvenile offense time, Age 13-17
- Table 5: Juvenile arrestees by primary ethnicity, Age 13-17
- Table 6: Juvenile offense type, Age 13-17
- Table 7: Status offense type, Age 13-17

Maps using GIS-enabled data

One common application of GIS technology is the sorting of data by geographic boundary and the creation of new datasets and indicators. Several examples are featured here. The **Juvenile Arrestees Per Capita** map shows the number of arrestees normalized by their population cohort for each judicial district. The result is the number of arrestees per 1,000 juveniles in the 13 to 17 age range. The **Juvenile Offenses Per Capita** map shows the number of offenses normalized by the number of juveniles in the same age range. GIS software was used to select those census tracts located within each judicial district. These tracts were then joined and used to aggregate census data. Age data were summarized for each judicial district. This allowed the creation of choropleth maps using raw offense and arrestee counts normalized by population counts.

A third map, entitled **Average Number of Offenses Per Arrestee**, was calculated by dividing the number of offenses in each district by the number of arrestees residing in those districts. This calculation assumes that those who live in a district are responsible for offenses in that district, which is not always the case. Nevertheless, this number does reflect the actual ratio between the number of offenses and the number of arrestees within a given district.

Another common application of GIS for crime mapping is the use of buffers to select and analyze the offenses that lay within the perimeter of certain types of establishments or institutions. The **Juvenile Offense Locations Within .25 Mile of Public High Schools** shows all of the public high schools along with a quarter-mile buffer. These buffers were used to select and count those incidents within that radius. A table was created, entitled, "Juvenile offenses within .25 mile of public high schools, Age 13-17," that lists each high school and the number of incidents that fell within the radius of the school address. In this case, the buffer was drawn around a point using the school address. When buffers are created and incidents within them are counted, new tables can be created that isolate those records for further analysis. Buffers can also be drawn around polygons. In cases such as schools, where the school grounds can be spacious, it would be more accurate to draw a buffer around the entire school grounds rather than a centerpoint. Polygon files for schools, however, were not available at the time of this study.

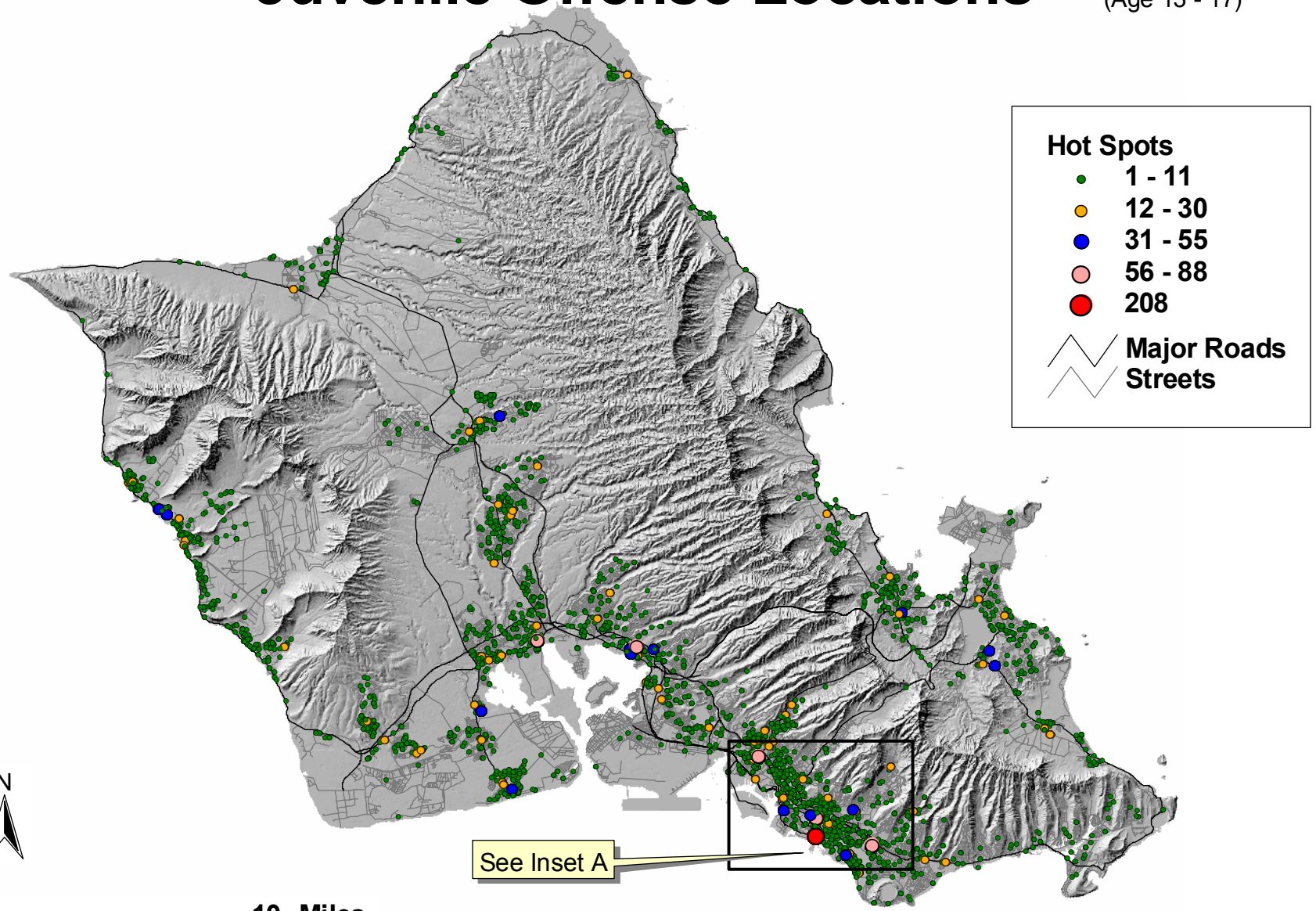
Similar maps and calculations can be done using other types of sites. One such map was created using the location of liquor outlets on Oahu, entitled **Juvenile Offense Locations Within .5 Mile of Establishments with Liquor Licenses**. In this case, the buffer radius was expanded to a half-mile.

Linear maps are also common in crime mapping. The map entitled **Offense Locations for One Juvenile** shows the approximate residence of a fictitious juvenile along with the locations of the offenses for which the youth was arrested. Lines are drawn between the residence and the offense locations, indicating the direction and distance of offenses from the home. Labels describe the numbers and types of offenses at each location. These types of maps are helpful to understand the pattern of movement among youth involved in offenses, particularly repeat offenses.

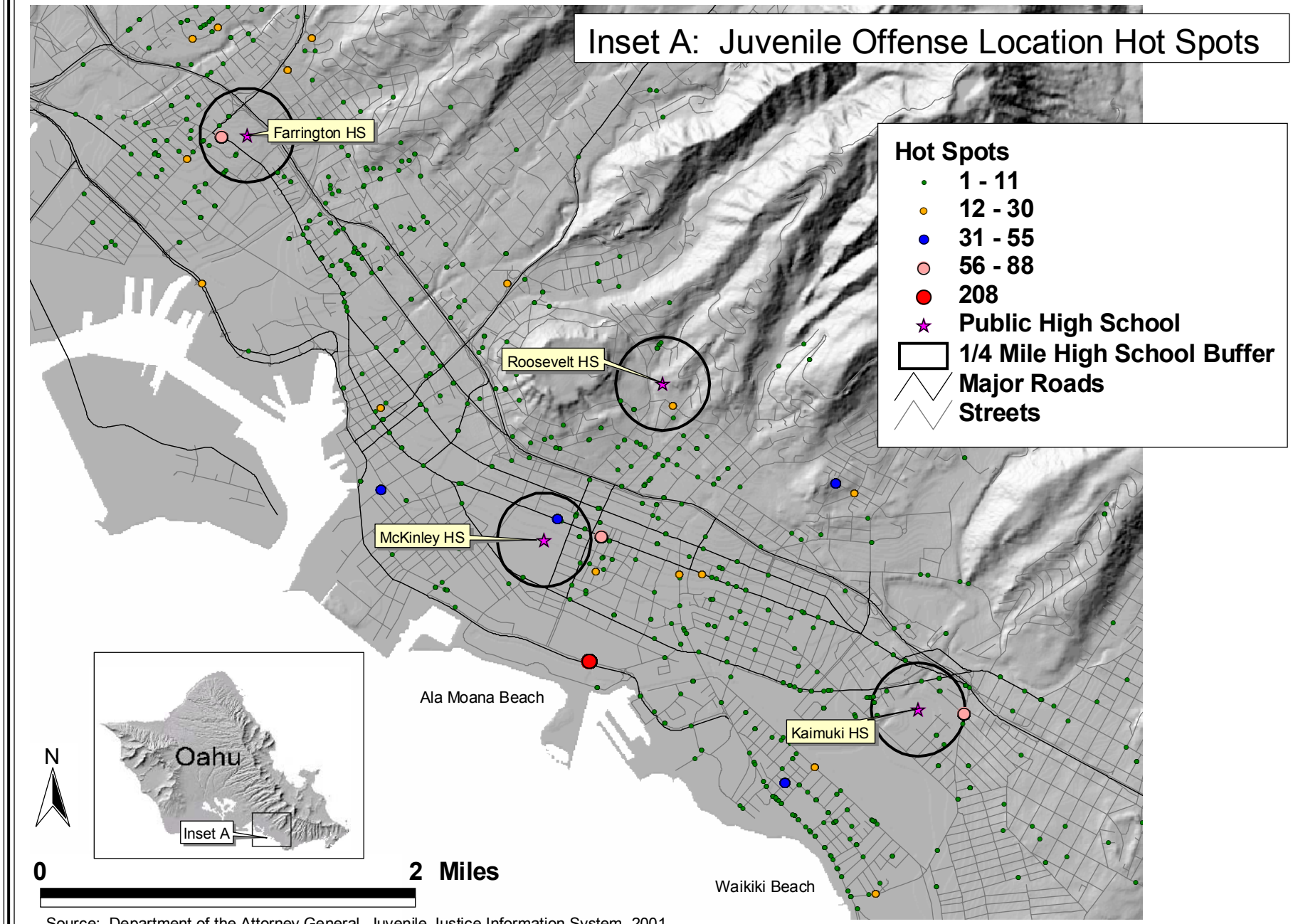
There are many statistics that can be generated using spatial statistical methods embedded in many GIS software programs and extensions. Examples of these are not included in this project. However, a list of references can be found in the Appendix.

Juvenile Offense Locations

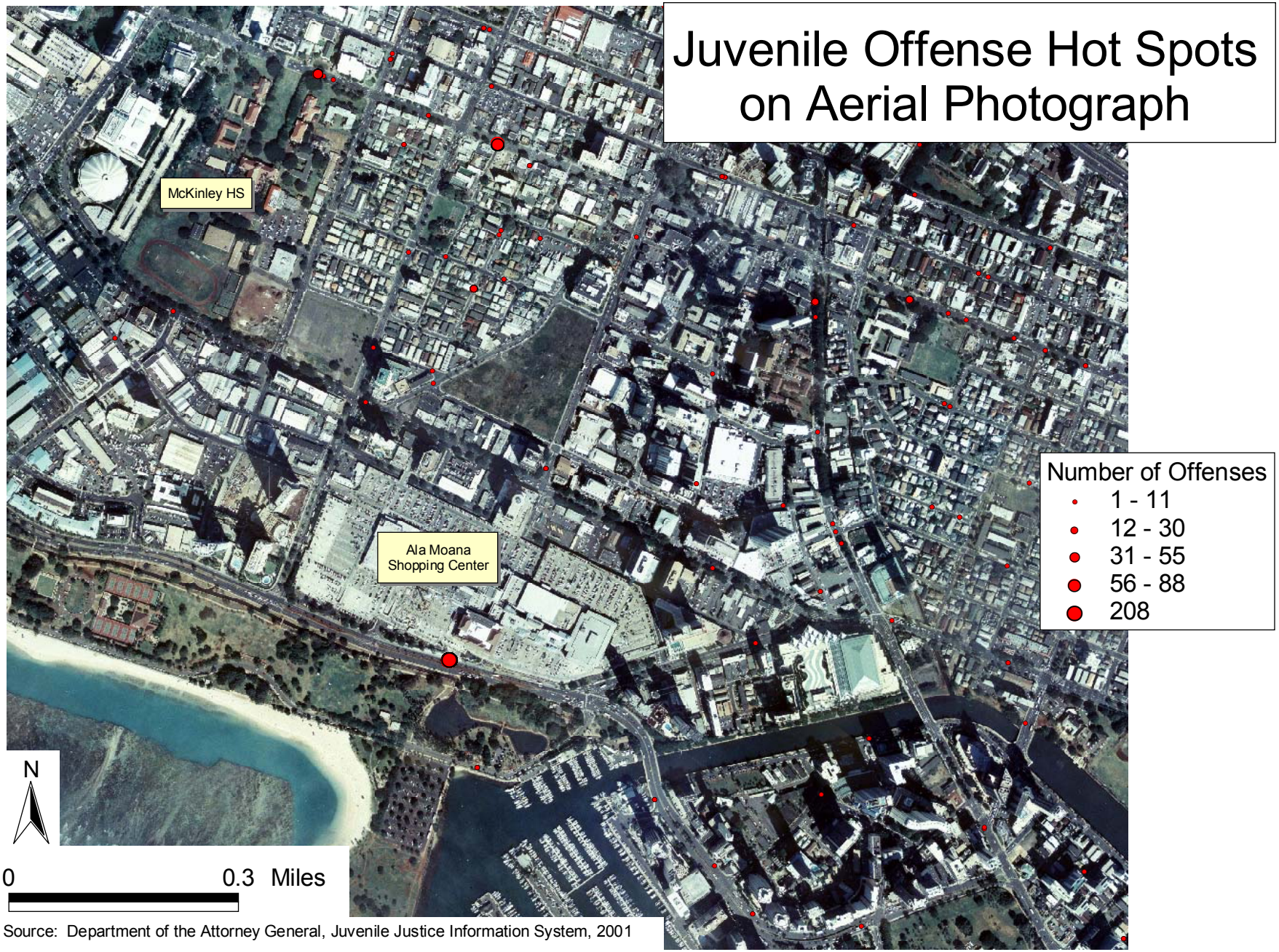
(Age 13 - 17)



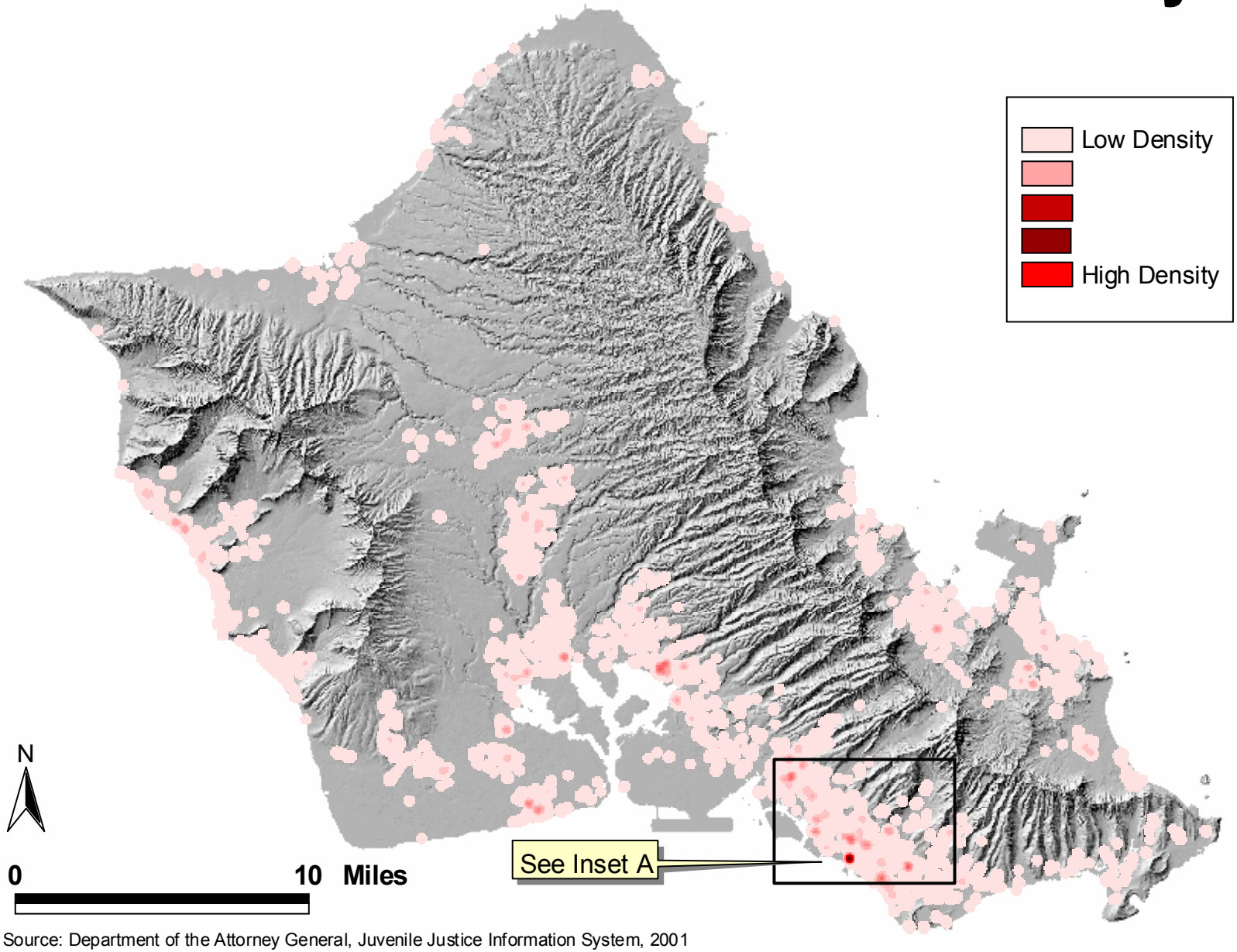
Source: Department of the Attorney General, Juvenile Justice Information System, 2001



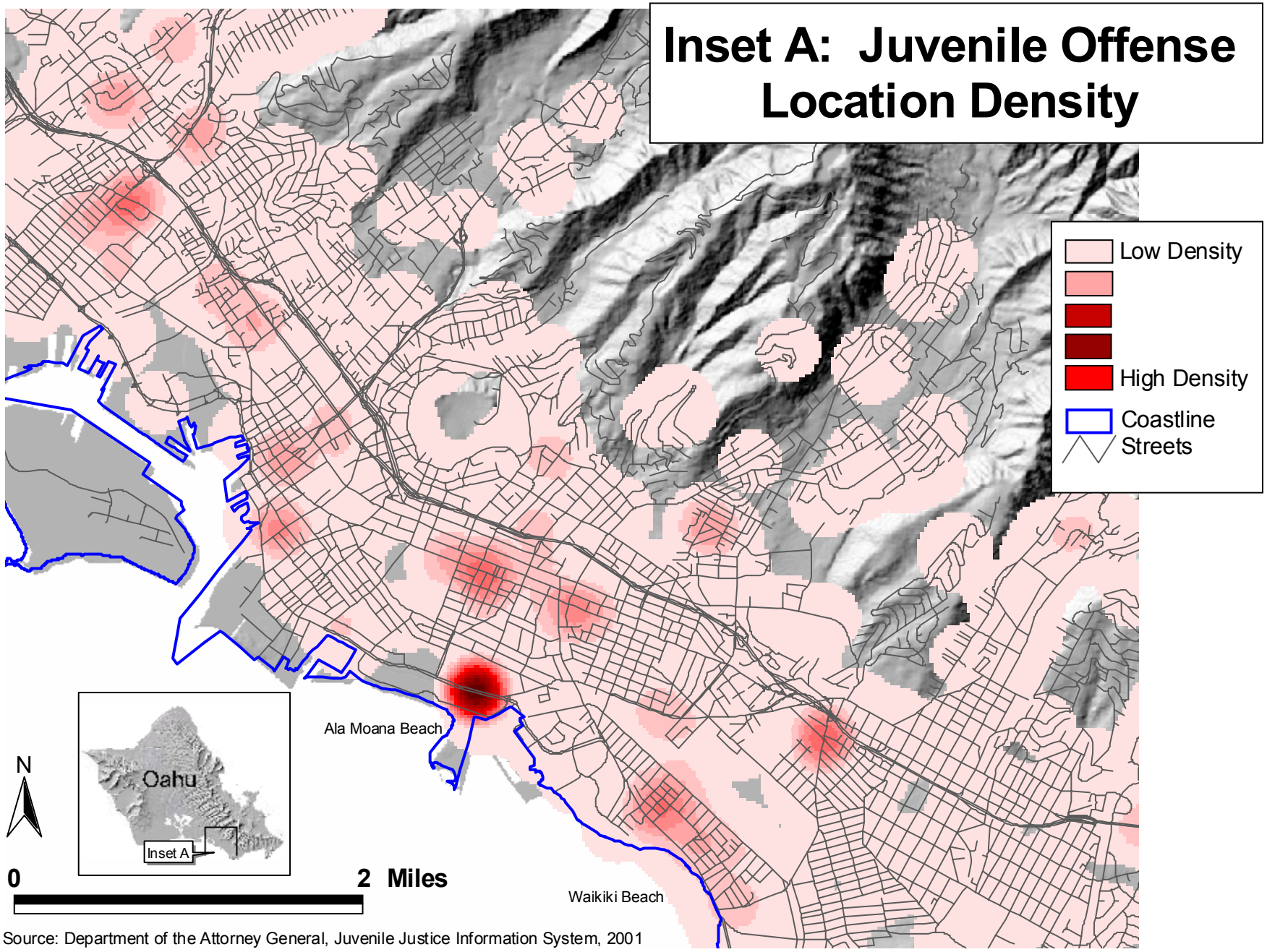
Source: Department of the Attorney General, Juvenile Justice Information System, 2001


Juvenile Offense Hot Spots on Aerial Photograph
McKinley HS
Ala Moana Shopping Center
Number of Offenses
1 - 11
12 - 30
31 - 55
56 - 88
208
N
0
0.3 Miles
Source: Department of the Attorney General, Juvenile Justice Information System, 2001

Juvenile Offense Location Density

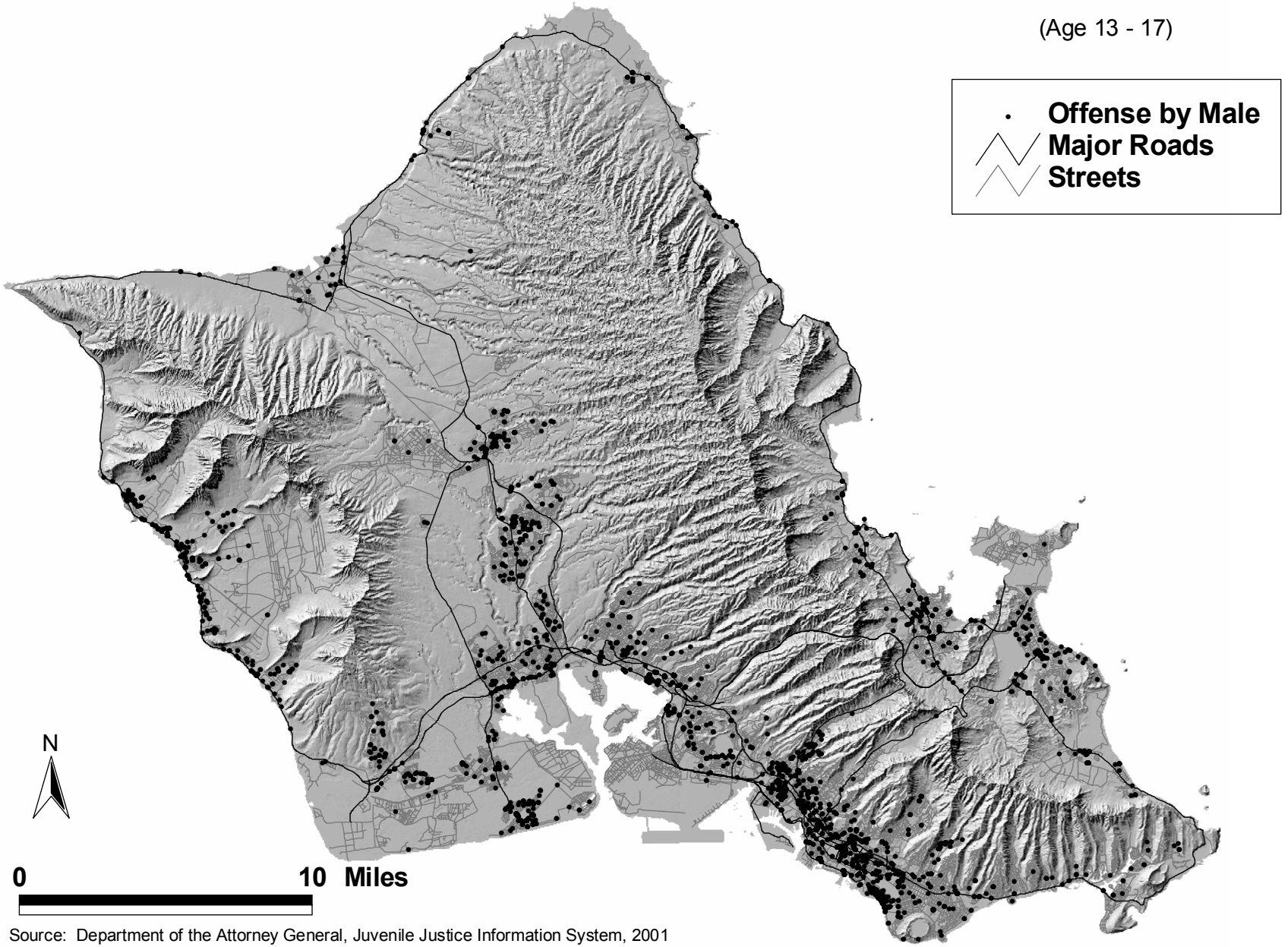


Source: Department of the Attorney General, Juvenile Justice Information System, 2001


Inset A: Juvenile Offense Location Density
Low Density
High Density
Coastline
Streets
Ala Moana Beach
Waikiki Beach
Oahu
Inset A
N
0
2 Miles
Source: Department of the Attorney General, Juvenile Justice Information System, 2001

Juvenile Offense Locations for Males

(Age 13 - 17)



Source: Department of the Attorney General, Juvenile Justice Information System, 2001