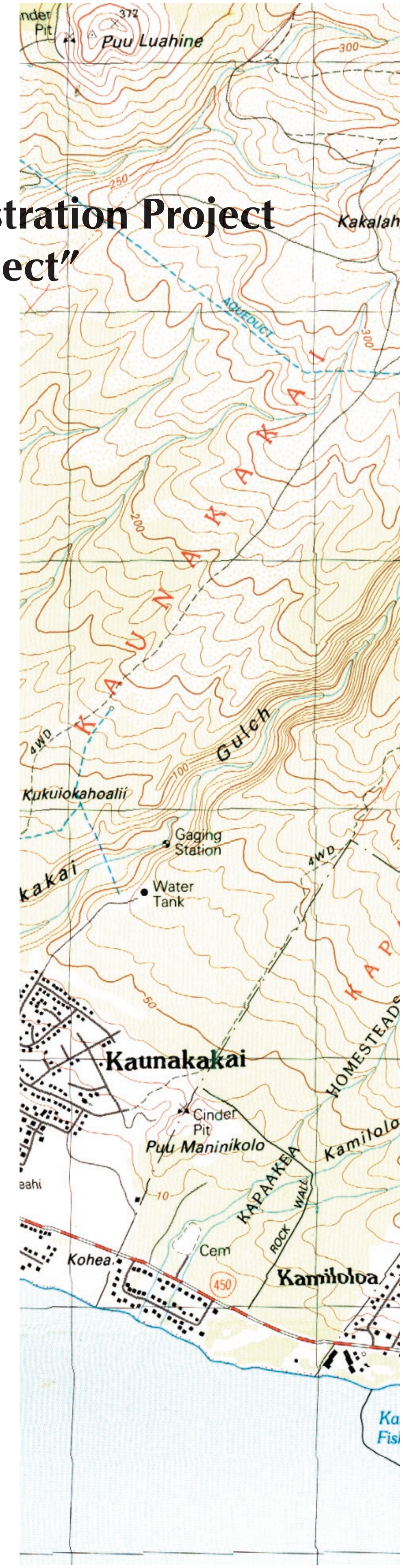
Final Report

Hawai‘i Framework Demonstration Project
“The Moloka‘i Project”



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Contract 43670

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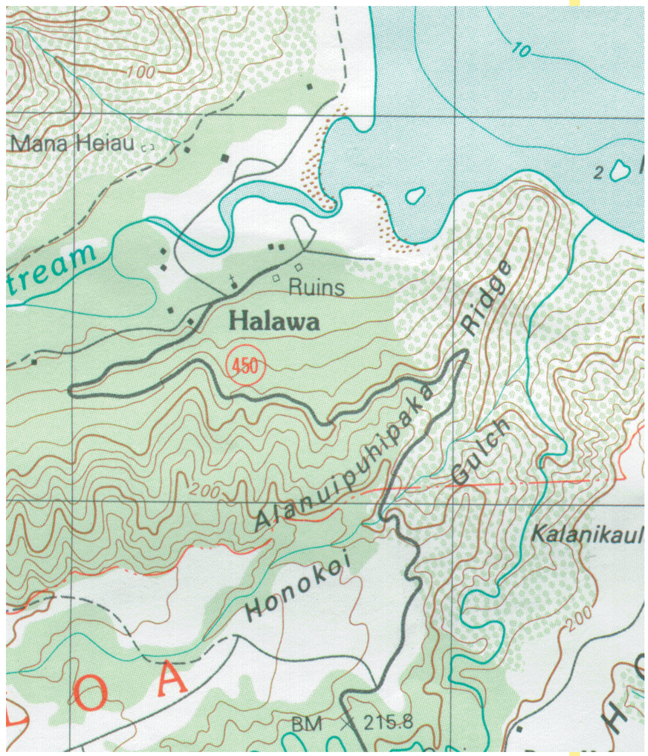
Executive Summary

Hawai‘i Framework Demonstration Project

MAPS AND DATA ACQUISITION

Map Compilation

With the exception of intermediate-scale maps prepared from Global Positioning Systems data, still relatively rare in the resource and planning fields, maps are compiled from aerial photographs and other maps. Only very large scale maps, usually relating to cadastral and engineering data, are maps compiled from field surveys. By the time that maps reach the intermediate scales such as a 7 ½ minute quadrangle at a scale of 1:24,000 or 1:25,000, they have gone through several compilation stages, usually experiencing a degree of generalization or modification at each phase. Because almost all maps, and the digital data sets derived from them, are compilations, it is absolutely necessary to record metadata (data about the accuracy characteristics of the data) that documents each compilation stage. If any data set is to ultimately be useful in decision making, every user must be able to have confidence in the accuracy of that data set and that confidence must be supported by careful records about how that data set was prepared.



Metadata

Data Frameworks

One of the common applications of current topographic map information is to serve as a base or "framework" for fitting or registering, other forms of subsequent data. In general, cadastral data are recognized as one of the most accurate forms of field measured data, serving as legal evidence to the boundaries of legal uses of land. It is impossible to show all land parcels in any meaningful way at a scale used by many resource and planning Geographic Information Systems. Therefore, the fabric of administrative land boundaries represented on intermediate scale maps are simplified and carefully selected for certain classes of perceived usefulness.

THE FRAMEWORK CONCEPT

Executive Order 12906

In the mid 1990s, the Federal Geographic Data Committee was formed with representatives from agencies responsible for mapping and the collection of data about the country's population and environment. Activities of the FGDC were outlined in Executive Order 12906 from President Clinton in 1994. The Order was titled "Coordinating Geographic Data Acquisition and Access the National Spatial Data Infrastructure". The main components of the Order were to:

National Spatial Data Infrastructure

(1) Develop a Coordinated National Spatial Data Infrastructure. This initiative was intended to strengthen policies relating to spatial data and involve State, local and tribal governments in the initiative. The FGDC was directed to utilize the expertise of academia, the private sector and professional organizations to implement this initiative;

Data Clearinghouse

(2) To develop a National Geospatial Data Clearinghouse. This section mandated developing a national digital system for access to information about data sets. As a part of this process, agencies holding and developing data were directed to create standardized documentation about the data sets. These data sets (metadata) that comprise the Clearinghouse that will be made available electronically. An important part of this initiative was to ensure procedures were in place to make metadata generally available to the public. Also a part of this section was the directive that cooperating agencies must determine if data they were going to develop were available elsewhere to avoid the costly duplication of effort;

Metadata

Data standards

(3) To develop Data Standards. The FGDC's component agencies were asked to develop standards for data that would insure that data produced by different agencies were compatible and that data collected under federal funds were done in a way that met the standards developed by the FGDC and its partners;

(4) National Digital Geospatial Data Framework. The FGDC will develop a plan of initial implementation of of a national digital geospatial data framework. The framework

shall include nationwide data that are significant to a variety of users and establish a process of maintaining these data. The plan shall address how the transportation, hydrology, and boundary elements might be completed to support the decennial census of 2000.

Data maintenance

STATE FRAMEWORK DEMONSTRATION PROJECTS

The Moloka'i Project

As a part of the mandates of Executive Order 12906, The FGDC announced a request for proposals to support the study and implementation of the concepts involved in nationwide Framework. The Framework Demonstration Projects were designed to support local projects involved with developing data and systems that supported the initiatives embodied in the Executive Order. In general these Framework Projects were divided into categories that reflected the main types of projected Framework data themes; cadastral, hydrography, elevation, and governmental units.

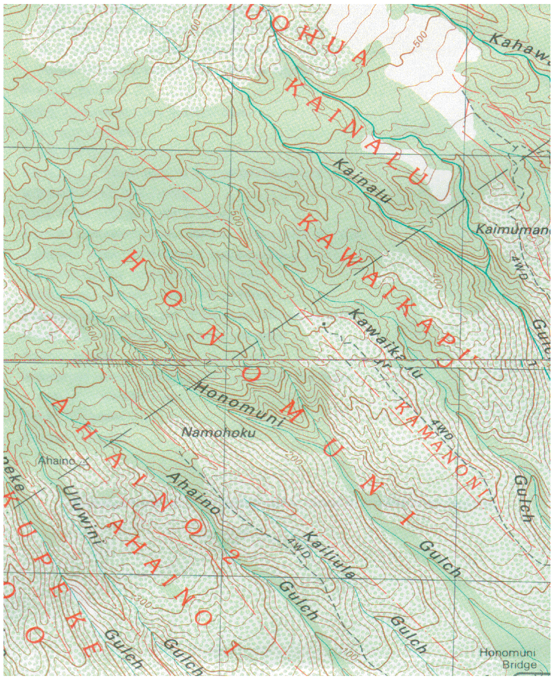
This document reports on the work conducted under one such Framework Demonstration Project entitled the Hawaii Framework Demonstration Project. This project will be referred to as the Moloka'i Project from this point forward since its subject area was involved with the administrative information shown on the US Geological Survey 7 ½ minute topographic maps of the Island of Moloka'i.

HAWAI'I AND THE FRAMEWORK:

Project working group

The proposal for the Moloka'i Project was developed by an informal GIS working group comprised of individuals from State, Federal, County, and private agencies mainly from O'ahu. The group had been meeting irregularly for several years to discuss issues of common interest in their different applications of geographic data.

Central to these issues were concerns about data standards, sharing data, and the development of new data sets for common use. In particular, all participants were troubled about the duplication of efforts that were being encountered in different state agencies involved with creating very similar data sets. We were also very familiar with the shortcomings of many of the federal digital data sets that were available



Project beginnings

for the State and were actively promoting efforts to increase the quality of these data. When the announcement requesting proposals in the second year of the Framework Demonstration Projects was received, the working group began to discuss the possibility of taking this opportunity to consolidate some of our concerns about local data and begin the process of implementing metadata procedures in our separate activities. As discussions proceeded over several months, several points solidified. First we wanted to propose a study of an area small enough that it could be analyzed in detail. In addition we wanted to study a type of data that was distinctive to Hawai‘i, a type of data where local knowledge could make a contribution to the analysis and at the same benefit local users.

The choice of Moloka`i

Existing digital data

There were two data characteristics that made us choose the small island of Moloka‘i as the subject of our proposal. First, in our use of the Digital Line Graphs of the administrative layer of US Geological Survey data for Hawai‘i in general, we found these data to be troublesome in how they were coded, reflecting federal agency difficulty in the unique Hawaiian land designation system. Many of the lines in the DLGs were not coded and many were coded incorrectly. In addition there was often confusion about which data were chosen to be included on the topographic maps and subsequently digitized into the DLGs.

Ahupua‘a land

The second characteristic was the nature of many of the administrative divisions represented in this data set. The major traditional land division in Hawai‘i is the ahupua‘a, an ancient political land management division. The ahupua‘a is generally based on topographic features and was the basis of the privatization of land in the mid-1800s. This land division remains an important cultural feature on the land and is the basis for most land surveys and divisions that have happened since the time of the mahele. Moloka‘i is the most traditional of the main Hawaiian islands and we felt that in this very traditional island, the link to the past in the definition and use of the ahupua‘a would make their use simpler to research.

FEATURE LEVEL METADATA

Metadata limitations

The concept and development of metadata since Order 12906, has been based on the idea that all the elements in a subject data set have the same accuracy and classification characteristics. All cartographers understand that this is a generalization that cannot help but lead to the mis-use of data. Even within the same data layer, information comes from many different sources developed at different times and often for different purposes.

Feature-level metadata

Some of the cartographers on the working committee wanted to explore a way of coding administrative data that would reflect its varied origins. This lead to often lengthy discussions of what came to be known as feature-level metadata, data on the heritage of the individual lines in the administrative data set for Molokaʻi. This type of analysis would involve researching the heritage of individual lines on the map. Compiling feature-level metadata is a task that can be approached in different ways, but most often was done by means reminiscent of the methods common in a detective novel.

The final proposal that was accepted by the FGDC proposed to study the quality of the administrative cadastral data layer of the 7 ½ minute US Geological Survey DLG data for Molokaʻi. The study was to approached as an experiment in feasibility of feature-level metadata to determine methods of classification of lines and making these data general available. This work was to be conducted in the general framework of general GIS application. An underlying question to the work on Mololokaʻi and by extension, to Hawaiʻi in general are the administrative layeris useful for registration of other geographic data.

RESEARCH METHODS

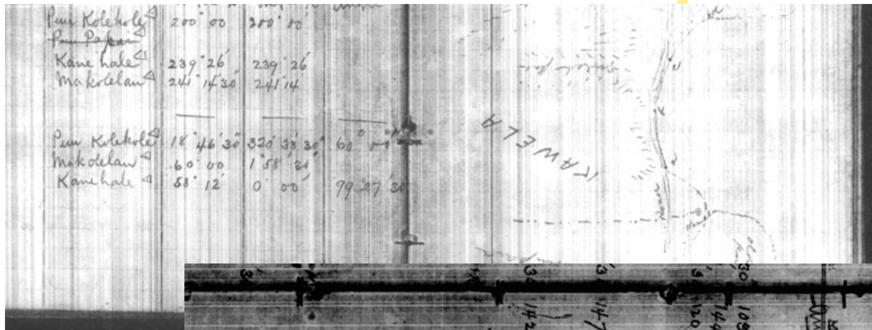
Project limits

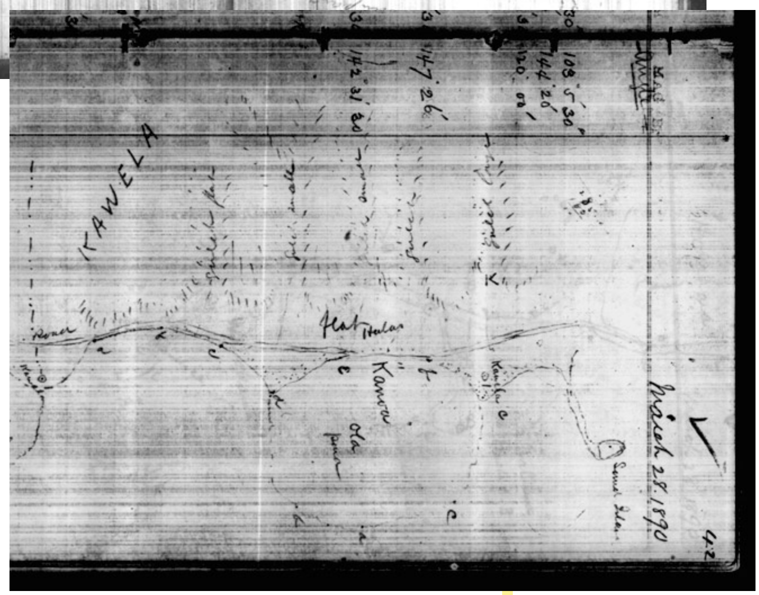
The scope of this project does not allow field data collection or the development of primary data. Field study of certain problem areas are allowed to resolve issues that cannot be approached by other methods. For example, if a certain adminisrative boundary appeared to be represented in error, it is beyond the scope of this project to conduct a legal survey to determine the real boundary. However, where legal descriptions exist of problematical boundaries, it is reasonable to replot them to determine the accuracy of the lines on the map or in the data set.

Lines on maps generally have a much longer history than the original compilers would like. One of the methods in tracing the heritage of lines was to explore old maps and surveys to try to determine when they first appeared, how they were first represented,

Tracing map line heritage

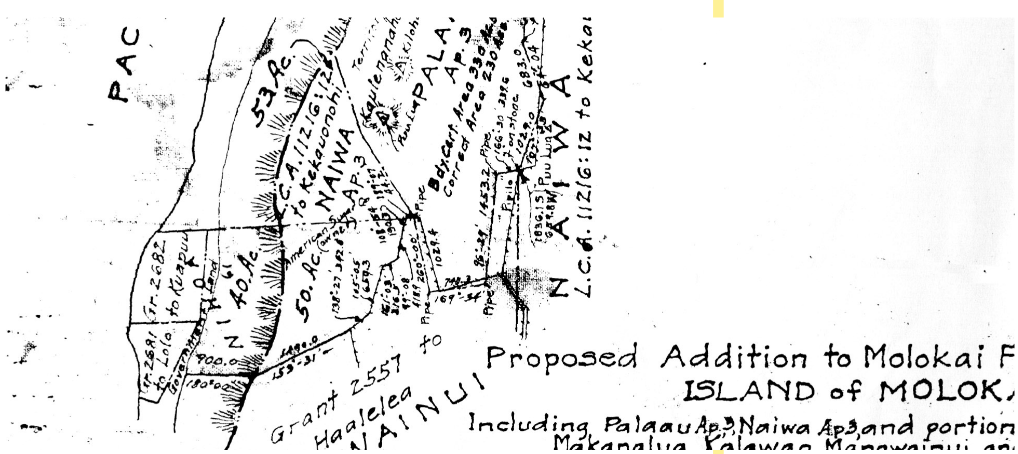
and how they have changed in subsequent mappings. One of the methods of research used here was to plumb the state surveyor's office and different state archive sources. On Moloka'i, the field notebooks of the surveyors were particularly helpful in tracing boundary origins and for the general information they contained. Two fragments of Monsarrat's fieldnotes are reproduced here. In all of his diaries and field notes, he includes details about buildings, informants and mispellings of placenames. They also contain quite detailed sketch maps that provide a wealth of information often not transferred to the final maps.





Where administrative boundaries were established in the recent past, it is possible to identify individuals who were involved in the determination. In these cases, their special knowledge is critical to understanding how the lines were drawn and often variable accuracy. Where the line surveyor or compiler cannot be identified or found, there are often written sources which help to document how the work was conducted.

In the map fragment relating to the growth of the airport facilities on Moloka'i, much information can be determined about line heritage from the legend annotation.



GENERAL EVALUATION

Are the administrative boundaries that are represented on intermediate scale topographic maps accurate representations of their large scale sources? Are they reliable enough to serve as frameworks for other information fitting? That is the subject of conclusion of this project and analysis. This report will detail the methods of arriving at the accuracy characteristics of these data and the explorations of making these data easily available to a range of users. The report will conclude with a set of recommendations about the reliability of using the USGS administrative DLG layer on the Molokaʻi quadrangles as a framework for other data.

Broader function of metadata and line heritage

As a part of this study other applications of the administrative line heritage were encountered. As we worked though the original surveys and field notes of the surveyors working on Molokaʻi in the mid 1800s, fascinating reports of work, people and places were detailed, especially in the field books. At this time we began to explore ways of distributing this information beyond a data base associated with a metadata statement. In addition, the expression of boundaries on the ground often have functional meanings well beyond their formal meanings. We began to try to find visible boundaries that might give additional information about the line rather than just a dividing line between ancient ahupuaʻa.

Given the results of these explorations, we began to explore more imaginative ways of making the metadata available to a much broader audience of users. Therefore, an unexpected outcome of this project was the development of an interactive data base that might be easily accessed by anyone with Internet access. In fact as the staff considered different ways of making the feature level information available, we could not find a better way than the interactive map form that we developed for quite separate reasons.

GENERAL RECOMMENDATIONS

Variable data

In summary, we found the administrative USGS DLG layer to be of quite variable accuracy. This is mostly because of the nature of ahupuaʻa and the different ways that the compilers have dealt with the data. Surveyed forms of the boundaries done for Land Court decisions associated with the mahele have sometimes been reinterpreted on the topographic maps to better follow the terrain as was thought to be intended by the originators.

There are places where ahupuaʻa have disappeared. Because of the unavoidable lag of time between update compilations, boundaries have been moved, disappeared in annexations, and changed in status.

The State Forest Reserve boundary that is a major feature in upland Moloka‘i delineates a functional boundary that encloses both leased private land and State land. As leases expire and new ones added, this boundary is very fluid and the different land uses associated with it that may make it visible in one year may not be the current location of the line.

The administrative layer of USGS 7 1/2 minute Moloka‘i quadrangles has widely variable accuracy characteristics

In Hawai‘i, the largest component of the administrative layer of the DLG is ahupua‘a information which is of variable spatial precision. A number of the boundaries have never been surveyed and have been interpreted differently by different compilers. In addition, a number of the other boundaries on the DLG have not been surveyed and are also of limited value as a framework. Therefore, in Hawai‘i the researchers on this project conclude that the USGS cadastral layer is not of sufficient quality to be used as a framework layer for general GIS application.

Moloka'i Project Background

Assembling a proposal for a Framework Demonstration

BACKGROUND

GIS Working Group

The Hawai'i Demonstration Project (the Moloka'i Project) grew out of an informal GIS working group that coalesced in the winter of 1996. This embodiment of the GIS working group was assembled by Craig Tasaka, GIS Coordinator, Office of Planning, Department of Business, Economic Development and Tourism of the State of Hawai'i and Nicole Vollrath, GIS coordinator of the National Resources Conservation Service. A variably sized GIS interest group had existed for some time, meeting irregularly when the organizers felt some issue of interest was arising that needed discussion by the GIS community in the State.

SMAC and the working group

There was a lot of interaction between related groups involved with mapping and GIS in the State. The long standing State Mapping Advisory Council members played a strong role in the GIS working group, however, there were often issues relating to non-US Geological Survey programs that made the SMAC a somewhat limiting forum with its only annual meetings.

When the Program Announcement of this program was circulated, the committee felt that the Framework Concept contained elements of a needed focused approach to several local issues relating to standards and data maintenance. The core of the founding group quickly expanded its invited participants to include other Federal and State agencies and broadened its scope to include County agencies, the University of Hawai'i, and private and not-for-profit groups active in GIS. Working together, the group began to form several threads that could be woven into a proposal that would encompass all of the interests of the group. In no particular order, the organizing concepts of the committee's interest are summarized below.

Committee interests

DATA STANDARDS: In a small island state, we have always had concerns about accurate mapping since land for any activity is scarce and expensive. Almost all of the geographic information systems in the state have been built on one of two standards depending upon the scale of their applications. The USGS Digital Line Graph DLG) forms of the 7 ½ minute quadrangle series were the base for most of the intermediate- and small-scale systems. These included the State GIS and some of the county efforts.

The large-scale Geographic Information Systems were based on surveyed land records and public works data. From the outset, all knew the match between the two bases was much less than perfect. However, the difference in these and other data sets made practitioners very concerned about what should be expected in the data that agencies generated, "borrowed", bought, or leased from others. There were sitations where the data were being generated in public and private agencies for specific purposes and then made available to other groups with little knowledge of its method of creation.

Heritage and metadata

DATA HERITAGE: Following closely on the heels of data standards and inextricably linked to it, was a need to know the accuracy and use limits that were present when data sets were generated. Knowing the purposes and constraints that a map or data set were made under, went a long way to projecting the reliability of the data. This rudimentary metadata, is a looser form of practical knowledge that relies more on personal knowledge of the steps involved in making a map or collecting field data. Even though it is a federal requirement, metadata in fact is rarely developed, since it usually takes special knowledge of someone involved in the compilation of the original source map.

Mixed compilations

Locally produced maps and data are relatively easy to document if they were done in a recent time frame. However, if a map was done even fifteen years ago, it is unlikely that the person(s) involved with the compilation will have a sharp memory of the situation and methods used in its creation. When maps are created at some distance in space and time, the methods are even more cloudy.

When the USGS compiles or revises a topographic map, a degree of local input is involved. Terrain and hydrographic items are generally derived from aerial photographs by stereoplotters well away from the map project location. However, cultural data are solicited from local agencies or contracted to be compiled from local firms. These compilation materials usually stay in the USGS records but the materials and the submission reports only document part of the compilation process.

Digital conversion and heritage

Once a map is committed to digital form, its heritage is usually quickly lost, thus loosing even barest elements of metadata. As increasingly large fees are associated with the decisions that result from the analyses of data, its heritage is on the minds of almost all users, especially with the threat of liability actions looming on everyone's horizon.

Competing data compilations

DUPLICATION OF EFFORTS: Many of the existing and historical data sets available at the beginning of computer aided mapping and geographic information systems age were clearly not adequate for the increased level of application demands that came with automation. This situation placed many agencies and firms in the situation of quickly developing more appropriate digital data for their needs, usually with more concern about speed and cost than accuracy. In one short period four different parcel or land base data sets were under development in Hawai'i and by mainland contractors of Hawai'i firms. All were completed and modified several times with parts of all of the source data sets still in conflicting use.

Data and applications

There are several soils data bases in existence, numerous sets of agricultural data, but fine grain climatic data are still scarce. Needless to say, all similar data sets possess very different resolution and accuracy characteristics since they were made for different intended applications. At last, after years of duplication of effort in developing new data bases, the wisdom of experience has started to overcome the proprietary and industrial secrecy concerns of interagency competition.

Sharing and special needs

There is a growing, if still wary, tendency to discuss developing one high quality data set in the place of two of three more specifically tailored ones and to support sharing of the efforts up to a certain point.

SHARED DATA: Coincident with concerns of duplication of effort, are the concerns of value-added proprietary information, involved in the sharing of data. Almost every agency and firm want to avoid the waste of funds associated with developing similar or identical data sets, however, each group's needs will involve different forms of the same data. Different groups will add value to data by special attributing and editing that will make a set specific to that group. Each group's specificity will force the set to take on a degree of uniqueness and value.

However, up to this point, there is a general interest in creating common data sets that are of a high known quality. These common data sets can serve as starting points for individual uses and value added efforts by private and public interests. Licensing agreements of the value added forms will hopefully guarentee rapidly updated information that often is not economically feasible in the public agencies.

Solidifying the GIS community

COLLABORATIVE EFFORTS: All of the representatives involved in Hawai'i's ad hoc GIS coordinating council were eager participants in how they could contribute to the common good of GIS efforts in Hawai'i. The commitment to this collaboration has taken several roles over the years. The State Office of Planning developed a GIS web site and made many of their data sets available over the Internet. Private groups made some of their value added data available for purchase. The City and County GIS staff have taken the lead in organizing a highly successful continuing set of conferences on general GIS progress and special topics such as metadata. A high data rate GPS base station was developed by the University and differential correction data were made available on the Internet at no charge.

GIS AND CARTOGRAPHY: Members of the professional communities of both Geographic Information Systems and Cartography were represented on the ad hoc committee but some of their end goals differed. It was important to the broader interests of the committee to maintain a project definition that would accommodate both closely linked groups.

Accuracy and applications

The group's differences are seen as issues of where emphases on accuracy are placed. Briefly, the cartographic community is more concerned about the base level of accuracy of spatial data. If there are two conflicting positions of a boundary or a feature, the cartographic and survey community will wish to resolve the issue or leave the discrepancy alone for future resolution, a situation which often leads to confusion.

Moving from general discussion to proposals

The GIS community's focus is on spatial analysis and often needs to prepare an analysis that is correct spatially and even if the data is bounded by lines that have been modified to allow the proper topology for the analysis software to perform properly. While Framework issues are aimed more at the GIS community than the cartographic, our committee felt that it was better to try to maintain the interests of both. And it this spirit of compromise and cooperation that gives the Molokaʻi Project some of its special flavor and a common interest on feature-level metadata.

FRAMEWORK CONCEPTS: Under the guiding work of the Federal Geographic Data Committee and its broad work relating to the variety of Framework ideas, the Hawaiʻi committee called a number of meetings to determine if we could become a part of this broader national initiative. Since starts had already been made by the University of Hawaiʻi, the City and County of Honolulu, and the State Office of Planning on websites and general data distribution, we first turned to the series of proposals that were solicited relating to Clearinghouse activities, but after several meetings decided that this was a phase of FGDC involvement that should await a little more maturity in the general State effort.

Therefore, under the committee leadership of Craig Tasaka, the committee applied for grants in the two areas of Developing a Geographic Data Coordinating Council and in a Framework Demonstration Project in the Cadastral sphere. Both projects were granted funds to begin and this statement represents the interim progress report of the Framework Project. The guiding or steering committee remains active in the process of the promotion and direction of both grants for the growth of GIS in Hawai`i.

Choosing Moloka'i for the demonstration project

THE MOLOKA'I PROJECT: The Moloka'i Project falls under the general class of a Cadastral Demonstration Project since the committee decided that we wanted to focus on the Administrative Boundary Layer of the USGS DLGs for a number of reasons specific to Hawai'i. The Island of Moloka`i was chosen for this Demonstration Project because of its manageable size and its range of land holding boundaries present. When the committee were discussing choices, almost each member could think of a class of boundary represented on Moloka'i. Moloka'i also possesses two additional problems that we felt would hold general local interest.

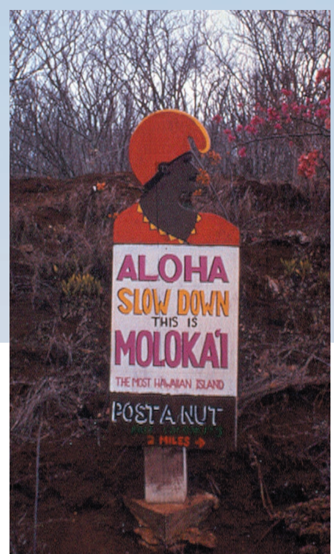
A significant number of the boundary lines on the Moloka'i DLG's were not coded or attributed with the conventional USGS major and minor codes. This lack of coding led to problems in many of the committee's application of these data. In addition, many (most it later turns out) of the administrative boundaries on the Moloka'i DLG's were the traditional Hawaiian land division, the ahupua'a. This important boundary has caused the USGS considerable problems in the coding associated with the DLG's since in many places it is not a surveyed boundary but is used administratively as a base for many other demarcations.

A third reason for choosing Moloka'i was that it is a part of Maui County. Maui County is important because this county maintains a funding base that allows for experimental work with GIS. The committee felt that if this project produced interesting and valuable results, that Maui County administration might be interested in helping with funding to continue the project to the other islands of the County.

It is important to understand that Moloka'i is not just another island in Hawai'i or anywhere else. It has a different type of population, a special history, and is comprised of strongly different types of terrain. All of these geographic elements affect is mapping history and its mapped data.

The Island of Moloka‘i

A traditional place facing modern pressures



THE REGIONS OF MOLOKA‘I

The island of Moloka‘i is situated mid-chain of the main Hawaiian Islands about half way between the big island of Hawai‘i and the most westernmost island of Ni‘ihau. Situated between the islands two population centers of Maui and O‘ahu, Moloka‘i has a relatively small population. The people of Moloka‘i have maintained more of their Hawaiian cultural character than any other island except (privately owned) Ni‘ihau. This cultural heritage finds expression in many ways on the island, and it had a

strong impact on the land tenure which is reflected in the modern boundaries found on current maps.

Moloka'i has several quite distinct geographic regions which have shaped cultural history and current landscape of the island. These regions also create differences in Moloka'i's mapping history. The small island of about 40 miles in the east-west direction and 9 miles at its maximum north-south extent is six completely different worlds.

Kalaupapa

Kalaupapa, the low peninsula on the north, extends seaward abruptly from the very steep 2000 foot cliffs and is the most isolated part of Moloka'i. In 1865 the Kingdom of Hawai'i started to purchase land in the community of Kalawao on the east side of the peninsula

and move its long term residents elsewhere to make room for a new population. In 1866, the Kingdom began to move patients contagious with Hansen's disease (leprosy) to Kalawao to isolate them from the community at large and later to establish a center for the disease's treatment. In 1969 Hawai'i finally abolished the isolation laws when the disease was no longer considered contagious. In 1980, the National Park Service took over administration of the peninsula and adjacent valleys as the Kalaupapa National Historic Park. Because it is the only home that some families have ever known, many of the earlier residents still live at Kalaupapa.

Kalawao County

Because of the special significance of the peninsula in Hawai'i's history, it is still considered the sixth Hawai'i county for many statistical purposes. In the United States Census, data are still set apart for Kalaupapa as the County of Kalawao.

West Moloka'i

Dryer West Moloka'i has always been more sparsely settled than the eastern and central parts of the island. Its rolling plains and scattered areas of sand dunes provide a stark contrast to the south shore and the windward valleys. In the late 1890s, most of the western land was purchased and consolidated into Moloka'i Ranch for its extensive cattle and agricultural operations. Throughout its hisory, the Ranch has experimented with many types of agricultural production and has contributed to many changes in the landscape. In the last thirty years, ranching and large scale pineapple cultivation have become less profitable and Moloka'i Ranch again began to diversify.

On the far west coast, the Ranch has created up-scale residential and resort developments taking advantage of the dry climate and little used beaches. In other areas in west Moloka'i, Ranch

eco-tourism camps catering to a different clientele, are widely advertised.
The town of Maunaloa, once the center of pineapple operations, is now being developed as a residential area and tourist destination.

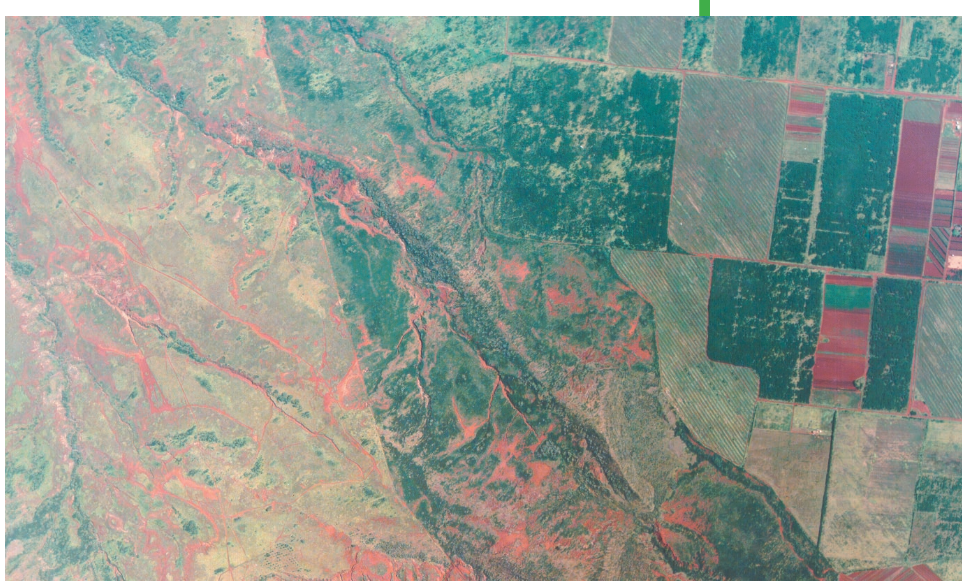
The Saddle

The transition from the Molokaʻi Ranch domain in the west is most strongly seen in the heavily agricultural central saddle. There are many distinctive cultural patterns on the land that point out the somtimes conflicting historical influences on the land.

Different agricultural and cultural practices cut across the fabric of the underlying land in the saddle. The patterns are easy to notice. In the aerial photograph below, an eroded gulch system crosses the scene from the southeast to the northwest exposing the red Molokaʻi volcanic soils where the surface vegetation has been removed.

Molokaʻi Ranch

Crossing the scene is an almost straight line dividing the east and west halves of the scene. This line is the fence line that separates the Molokaʻi Ranch lands from the rest of Central Molokaʻi. Cattle grazing to the west of the "line" has systematically deceased the vegetation making the Ranch land appear lighter in the image. To the east of the "line", before the field pattern begins, the gulch land is ungrazed land with a darker more dense vegetation. Moving east across the saddle is Molokaʻi's most productive agricultual land. Molokaʻi Airport is centered in this scene. To the north of the airport is the systematic grid pattern of the Hoʻolehua - Palaʻau Hawaiian Homelands. To the



south is the irregular pattern of more intense commercial agriculture.

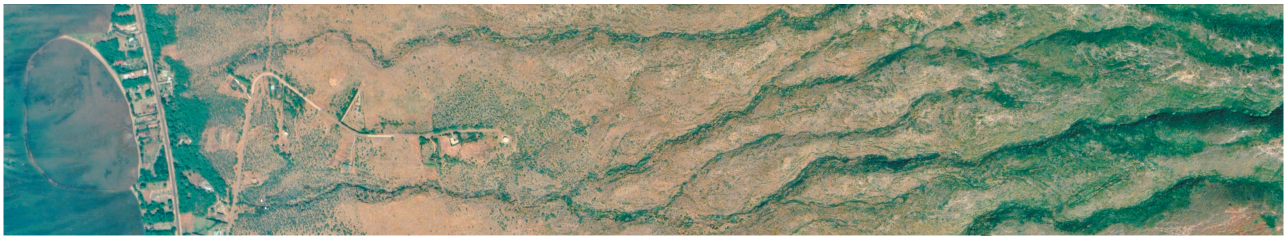
Windward Valleys

The windward valleys of Waialeia, Waikolu, Waiohookalo, Pelekunu, Wailau, and Papalaua have always been isolated from south Molokaʻi and commonly only accessible by sea. There is one tortuous trail from south Molokaʻi into Wailau but it is rarely used and not well maintained.

These lush valleys have been home to Hawaiian settlements for centuries and been a stronghold of traditional Hawaiian culture and practices. The westernmost valleys are now part of the Kalapaupa National Historical Park but this region of steep walled valleys is still a geographic area apart from the rest of Molokaʻi. Today small communities of Hawaiian families live in these valleys and maintain a traditional lifestyle very separate from the rest of Molokaʻi and the State.

Up-country Molokaʻi

Up-country Molokaʻi is the land extending from the heads of the deeply incised valleys of the north shore, forested and often cloud covered, to just behind the southern coastal strip of permanent occupance and use. At the lower elevations, there is some agricultural use but the land is for mainly in pasture and ranching.
At the higher elevations,



much of the land is designated forest reserves. However, population pressure is pushing subdivision and development into this zone and in areas such as Kaunakakai and Kawelā, houses have begun to move up the dry slopes above the agricuturally rich and densely populated coastal zone.

South shore Moloka'i is home to a large part of the island's population. It is a narrow zone of coastal vegetation, farms, and homes adjacent to the very rich reefs and ancient fishponds. This shore of Moloka'i has the most dense fishpond development of any of the Hawaiian Islands. Just seaward of the fishponds, maintained into the present, is a very rich reef flat that supports an important local fishery. The clear and varied reef is broken by 'avas (channels) cut by freshwater streams whose water

South shore Moloka'i

retards saltwater reef organism growth. These ʻava support a wide range of both shallow and deeper water marine life and provide easy canoe access to deep water.

The south shore is also home to the most concentrated residential land spreading eastward from Kaunakakai into the traditional coastal agricultural lands. In the far east of the island, the south shore is home to traditional farmsteads and is a center of Hawaiian activism and cultural traditions. As the road narrows and drops into Halawā valley, one enters a traditional part of Molokaʻi that is quite different from the rest of the state.

Kaunakakai

The western end of the south shore is home to most Molokaʻi's permanent residents. The main town of Kaunakakai is center to most of the services, tourism, and commercial activity.

Kaunakakai's pier is the main way of moving heavy freight in and out of Molokaʻi since the size of the airport can only take light commercial jets in good weather. The Kaunakakai pier also is the location of fishing and recreational vessels.

HISTORICAL MAPPING ON MOLOKAʻI

Even though Molokaʻi is a small island it has a great geographical diversity. Through this diversity and the different types of human activities associated with the regions, one can expect that there would also be a difference in the type of surveying and mapping by region. In the more densely populated south shore, land parcels are smaller and carefully surveyed.

Place and mapping

In the windward valleys, most of the boundaries are traditional ahupuaʻa and often described by reference to physical features rather than to trigonometric control. Some of each class of the different types of boundaries find their way onto topographic maps. However, there is a rather large degree of inconsistency on what are chosen to be represented and how they are plotted.

TRADITIONAL PATTERNS OF LAND-USE ON MOLOKA'I

Ahupua'a

Traditional Hawaiian society did not subscribe to Western concepts of land ownership and the associated boundaries that caused many forms of conflict from familial disputes to wars in the West. Hawaiians did not view land as property, but as something akin to a relative, a relative who needed caring for and who would in turn provide its occupants with the resources needed to sustain a reasonable life.

However, this did not mean that the use of the land was not organized in a political or functional way. According to tradition, about six centuries ago, Hawaiians developed a formalized system of land designation, called the ahupua'a, which had both a political and functional utility. The principle unit of land at the island level is the ahupua'a. There is a large variation in how these units were defined, but the main underlying concept is to develop a political living unit where a group of families had access to the resources necessary to establish a comfortable life for the villages located in the ahupua'a.

Ahupua'a literally translates into English as "pig altar", referring to a location for tribute on the roads that encircled islands. An actual altar may have existed at some time as the concept of ahupua'a was new to the populaion as a whole. Ahupua'a are simplistically described as a pie-shaped segments of land that extend from the top of the mountains to the sea across the bounding reef, giving people access to marine and forest resources and space for agriculture and homes.

There are however, many variations to this general model, although the concept perseveres. On Moloka'i there are ahupua'a that do not have access to mountain forests and there are ahupua'a surrounded by other ahupua'a. While the traditional ahupua'a were aligned along ridges, West Moloka`i has ahupua'a boundaries that cross plains. Central Moloka'i's unusual Manowainui Ahupua'a is comprised of two unconnected units.

Konohiki

As much as a resource unit, the ahupua'a was a political unit. In the beginning, there may have been actual altars located at the general boundaries to aid in teaching people the boundaries, or transition zones. However, in the later centuries, boundary was known to all as a part of the common oral tradition of a moku or district. The ahupua'a was 'managed' by a konohiki. The konohiki supervised maintaining irrigation systems and performed other social and agricultural functions. This person answered to the member of the ali‘i who was given domain over the ahupua‘a by the king or member of the royalty in power at the time.

Historically, the ahupua‘a boundaries could change and the existence of Apana (parts or divisions) now on the topographic maps are pointed to by historians as ahupua`a in transition at the time when Western forces stopped the normal political evolution. It was more common for there to be political groupings of aupua`a rather than to be constant modification of their boundaries.

Although the ahupua‘a is and land unit that stretches back for centuries before Western intervention in Hawaiian culture it is still a very important cultural concept whose expression strongly affects every land divison that followed.

‘Iles and Leles

The ahupua‘a is not the only land division that was designed to organize land in traditonal society. The smaller units of land management -- ‘ilis and leles -- as important as they were to the formal division of land in the mahele when Western influences began to transform the landscape, they usally do not find their way into current mapping as persistantly as the ahupua‘a do.

EARLY MOLOKA‘I MAPPING

Mapping, surveying, and land ownership are tied inextricably to Western influences in Hawai‘i. The type of cadastral data that are the subject of this report began to be produced well after the rather sparse examples of mapping produced by the waves of explorers from different nations and the whalers, merchants, and settlers that followed.

Changes in land Tenure

The cadastral changes that accompanied the missionaries and other early Western settlers was inevitably accompanied by surveying and mapping. Some notable mapping was done by early missionaries and their students at Lahainaluna. Their work was the first to systematically represent ahupua‘a on maps, however, it took the process of the mahele, or the division of the land, to begin cadastral work in earnest.

THE MAHELE

The process of beginning the transfer of the King’s lands into private ownership started in the 1840s under the encouragement of missionary influences. The first Mahele took place in 1848 which divided the lands between King Kamehameha III and his loyal chiefs. After this division of lands between the Ali`i and the King, King Kamehameha kept some lands for his own use and transferred a large amount of his land to the people as government lands.

The first and second divisions of the land

Shortly after, the Kuleana Acts of 1850 allowed the people who occupied and worked the land to claim the areas that they worked and maintained. To be able to claim and gain title to areas of personal doman (kuleana) was far more revolutionary than the earlier mahele.

Extending land title the occupants

However, this process of commoners claiming the land under the Kuleana Acts was an expensive and arduous one. Testimony had to be produced that demonstrated that the claimant did indeed occupy the land claimed. The claimant also had to hire a survey done and attach a map of the claim to be filed with a substantial fee for those times of subsistence agriculture. Relatively few claims were actually awarded compared to the number filed. And the number of claims that could have been filed was very large compared to the number actually filed. However, the Kuleana Acts produced an instant need for surveys and surveyors.

The first surveys

The surveys that were made to support kuleana claims were simple drawings that described the extent of the land claimed in a metes and bounds description, but were not tied to any kind of systematic control other than when the land abutted a distinctive natural feature or a piece of property that was known in some other way. This type survey has continued to cause difficulty to clearing title until this day. All of the land claims were made and designated according to ahupua'a and lists of the approximately 1300 ahupua'a in Hawai'i were important parts of the mahele process.

Very early in the process, it was necessary to describe the ahupua'a as well. And many of the early surveyors were engaged in describing ahupua'a boundaries at the same time they were developing kuleana maps. In the 1850s, Robert Pease began these surveys on Moloka'i and continued making them for the next fifteen years. There were no maps associated with the metes and bounds descriptions until late in the century when M.D. Monsarrat resurveyed many of the boundaries and made the first general maps of Moloka'i.

Variable survey coverage

The ahupua'a surveys were not done systematically. In places where there were many kuleana claims or where whole ahupua'a were given to an ali'i, the ahupua'a themselves were surveyed, and where the kuleana's were on the edge of an ahupua'a, its "boundary" was included in another survey.

However, in ahupua'a where there were few or no claims, the surveys were only done informally or not at all. An ahupua'a might be described as the line between a point on the ocean along a watershed to a pu'u (small crater) well inland. On some islands the Westernization of the land happened so fast or so completely that the ahupua'a fell into disuse or were confused as the oral traditions were lost or diffused. However, on Moloka'i, one of the most traditional of the Hawaiian Islands, the ahupuaʻa as a form of land description remains solid with three exceptions. These three are listed in the Land Commission Awards but do not appear on current maps.

THE TERRITORIAL SURVEY

All of the Kuleana claims surveys were done without monumented control. Almost two decades after the claims surveys were done, the Hawaiian Government Survey established a network of trigonometric stations on Molokaʻi, often on the same physical features that defined the upland parts of the ahupuaʻa and thereby were tied into a control network after the fact. These control points were established in the 1870s and for the most part remain the basis of modern surveys on Molokaʻi.

In the period of 1890 to 1897, M.D. Monsarrat conducted meticulous general surveys of Molokaʻi which resulted in the first intermediate scale maps of the islands. These surveys mapped all types of details on Molokaʻi including houses, hydrographic features, ahupuaʻa, and tied it all to the trigonometric control set in place years earlier. Monsarrat was a prolific surveyor and mapper and was known for his careful work and his reliance on local informants for placenames and the location of ahupuaʻa boundaries. His maps of Molokaʻi in three sections have remained the standard for many purposes into the current time. The compilers of the ahupuaʻa boundaries for the 1983 series of 7 ½ minute US Geological survey topographic series note using Monsarrat as their source for ahupuaʻa information.

Monsarrat's first detailed surveys

Many of the surveyors of the 1850s to 1880s were primarily self taught and using the most rudimentary of instruments and often used them long after damage should have retired them or required major repair. One of the surveyors that conducted many of the kuleana and ahupuaʻa surveys on Molokaʻi was not highly thought of for his care and accuracy by the head of the Hawaiian Government Survey. This is apparent since Monsarrat re-surveyed many of the ahupuaʻa on Molokaʻi as a part of his 1890s mapping. In one case, the difference between the two surveys resulted in an acreage discrepancy of over 8000 acres. However, Monsarrat did not repeat all the surveys that were done earlier and his maps appear to have accepted some of these data. Unfortunately these data have been carried forward into the modern topographic maps.

Monsarrat's work into the present

MODERN CADASTRAL SURVEY

By the turn of the century, cadastral mapping on Molokaʻi had incorporated the earlier boundary surveys and were building on these data and Territorial control data to continue the process of surveying the land for subdivision and transfer of ownership. Both these modern surveys and the work of earlier 19th century surveyors find expression in modern topographic mapping and their derivative DLGs.

A mixed heritage

However, some of the territorial heritage has remained with us. When the 1983 series of topographic maps were in preparation, the USGS made the major decision to completely redo the Moloka‘i maps. They concluded that there were enough problems in the original control work on Moloka‘i that the control needed to be corrected and all of the data that was dependent upon it. That series of 1:25,000 maps contained new contours, and represented a complete new compilation.

New compilations

It is with this complex new topographic series that this project began its analysis of the heritage of the many and varied sources of information included in the new compilation. As this report is completed, a new series of topographic maps are in their final stages of preparation and should be available by the end of the year 2001.

GOALS AND PHILOSOPHY

The goals and the underlying philosophy of the Molokaʻi Project are two quite separate but intertwined aspects of map analysis. The goals of the Project were defined and negotiated in a way so that a set of deliverables would be developed that would mesh with the other interests in Hawaiʻi and the goals of the national program. However, each project's specific goals are individual since projects were developed to satisfy local needs.

Below the concrete goals of a project are a set of directions and philosophies that the project wishes to see expressed through the execution of the official goals of the project. In this section, we wish to separate these as much as possible so that their differences and complementarity can be analyzed separately. When the actual analysis of the data and the presentation of the findings merge the two, hopefully the original flavor of the two will remain apparent and intact.

PROJECT GOALS

Framework recommendations

Of course, the overriding goal of the Framework Demonstration Projects is to develop a set of recommendations to the State GIS community about the efficacy of using the Molokaʻi administrative layer as a reference or framework for fitting other non-surveyed data. Since so many of the boundaries represented on the Molokaʻi topographic maps are visible on the ground and in aerial photographs, it is tempting to use these lines as a registration device for other data. However, within this broad goal, the Molokaʻi Project has four sub-goals that affect the final recommendations. These "sub-goals" are more methodological than substantive in tone and will shape how we approach the main tasks of the project. The following sections expand upon the four methodological goals that form the threads of our approach to the Project.

Feature Level Metadata: The concept of metadata is central to our goals. Everyone on the Framework Working Committee is vitally interested in the quality of data that they use to make day to day and long-range planning decisions.

However, in many discussions that participants have had, we have felt that the way that metadata is currently structured does not completely meet the professional's needs. We feel that the administrative levels of metadata content are useful and well served by the current structure, especially by the group who is searching clearinghouses for information to build a local GIS.

A more detailed metadata

Every surveyor and cartographer knows that simultaneous data capture and development is a long way from a historic reality. Only when GPS and remote sensing are the main sources of field data, will there be real consistency in data - consistency that the concept of metadata was designed to accommodate. Even with the dominance of GPS and remote sensing analysis, there will be a wide range of accuracy depending on equipment and field conditions. In reality, data on a coverage, even a small coverage, can be developed with a wide variety of methods and from a wide variety of time periods. We feel that the data user needs to know the details of the data's compilation, more than an general statement about a coverage.

Variation within a data set

After a great deal of investigation, we believe that the USGS administrative DLG layer / tiles for Moloka`i contain data developed from the years of 1854 to 1981. We feel that every user of these data need to know which line came from which survey or demarcation. Therefore, metadata must be expanded to account for variations of accuracy and heritage within a coverage. Knowing the variation in our subject data set, a major goal of this project is to experiment with expanding metadata, both in scope and in detail to reach to the feature level through a coding that allows for spatial distinctions in the data set.

An exceptionally long boundary history

Data Heritage: In order to be able to develop data on a feature level, several things must be done. First, the subject data must be structured in a way that allows meaningful data units to be researched. In hindsight, many feel that the data in the USGS DLG system was structured in a way that made more sense for the capture method than to the use of the data. To investigate the meaning and heritage of a administrative or cultural line on the digital form of a topographic map takes a degree of deconstruction and then reconstruction into useful user units.

Analyzing the data in the USGS format

Once useful units are assembled, then feature analysis can proceed with a large dose of detective work, tracing down who drew the compilation line and when. When the heritage of a line is determined 'rarely with an absolute degree of confidence', judgments can sometimes be made about the real or relative accuracy of that line. However, in many situations, it simply cannot be determined who made the line or caused it to be made. This situation is frustrating for both the researcher and user, but valuable non-the-less. The process of determining the heritage of a line is similar to title abstracting, long tedious work, but in the end of great value to the client.

Accuracy judgements

Data Structure and Access: The development of a data structure that will eventually lead to a feature-level metadata is very difficult for a number of reasons. The first assumption, and we think a critical one, is that the original data that is used to build a coverage must not be modified. It is beyond the scope of an oversight project such as this one, to edit data created by another agency. Therefore, while we are attempting to link our heritage work to the original data, it cannot be modified. This forces us to add layers to the original to develop user useful links which can ultimately lead one directly back to the original data. We felt that directly coding the original DLG lines with many heritage attributes would lead to a data overload that served no useful purpose.

Preserving USGS DLG structure

The data on Moloka'i were therefore collapsed first from USGS line segments to features -- functional line segments -- and then to boundaries, administrative units of the 'one to many' coding type. It is with the boundary unit that the heritage search begins. However, the ability to search into the data set cannot be based on the boundary unit alone, so a much more complicated structure must be maintained. For example, if one needs to search for all of the ahupua'a of a certain class of survey definition, backward links must be maintained as well as forward ones in order that degrees of accuracy can be traced to the source material.

Building features

This structure only maintains the identification links. The actual coding will be open ended depending on what was found in the heritage research. Although some projection of the composition of the elements in the final feature-level metadata can be made, a classification that can create even greater levels of detail than may be desirable. A boundary has a number of components or attributes, all which enter into its application by different users. First, a boundary, by definition, separates spheres of jurisdiction or influence. This attribute of a boundary has been particularly difficult in the Moloka'i Project since part of the boundaries on the DLGs have been coded according to what they separate and part have been coded by their meaning --- and part remain uncoded by either factor.

Internet access to data

Public Data Access: In the spirit of the definers of the National Spatial Data Infrastructure, access and sharing underlies all the tenets of the initiative. In this vein, the Moloka'i staff wanted to take their efforts in developing data heritage and feature-level metadata to broadest possible audience and not just limit it to the GIS community, although it is likely that these professionals would be the largest clients. To this end we have made provisions for making the data accessible through the Internet in a graphic access form.

We developed access to the data set through a graphic interface to the raw data from the DLGs. By this free and open access, we hope to bridge the gap in many lay map-user's minds that all the data contained on a topographic map (and its digital derivative) is perfectly accurate. We also hope to educate about the meaning and sources of mapped information. For the professionals, we hope the easy access to feature-level Metadata will involve them in the real accuracy of data and how it affects their decision making process.

The Contractual Embodiment of the Goals

Contractual agreements between USGS, DBEDT, and the University of Hawai'i

The Department of Geography at University of Hawai'i at Mānoa entered into a contract with the Department of Business, Economic Development and Tourism, Office of Planning to conduct the research goals described above. The Office of Planning has translated these goals into a defined scope of services. These services are outlined for reference to the steps described in the methodology chapter to follow.

1. Research and identify all sources of information that were used to compile the US Geological Survey boundary data on general boundaries, large government and private land holdings on the Island of Molokai as represented on their1:25,000 topographic map series.

2. Automate these sources, as appropriate, and as necessary, convert

data to NAD83; prepare federally compliant metadata for these data and submit for State approval.

3. Carry out field checks throughout the period of the project, as necessary, to verify boundary accuracy.

4. Prepare and submit for State approval, feature-level metadata for the compiled data set.

5. Prepare and submit for State approval, recommendations to the Framework Working Committee (FWC) on developing a final framework boundary.

6. As required by State, provide assistance to the FWC in the preparation of a final report to the US Geological Survey. Submit for State approval, all recommendations made to the final report.

7. Develop and update a web page to keep interested parties informed on the progress of the project and to solicit input. Submit initial web page for prior State approval.

PROJECT PHILOSOPHY

Many users of maps and GIS data bases think little beyond the dimensionless representation of some linear feature as it is convolved with or truncates some polygon feature. However, there are many steps of definition, refinement, generalization, measurement and symbolization before a line is symbolized by a series of points in a coverage. All of these steps affect the geometric coordinates of these points or vertexes and provide a conceptual limit to their accuracy and application.

The loss of a line's heritage

In some ways, there is an unfortunate stripping of a line's history when it is taken out of its graphic context and converted to a digital form. All the historical points and graphic contexts are important to the line's further application and usually are not attributed in any useful way. It was the intent of this project to develop as much of a line's heritage as possible and make sure that it was attributed in a way that would increase the user's understanding of a geographic process beyond a simple geometry.

Assigning heritages to lines is not a simple matter because different segments of a line may have different histories. A boundary that moves from the coast up one side of a stream and then climb onto a plateau and continue to a certain peak may have a functional meaning beyond that of a simple dividing line between the development rights of two land holders. In its lower course, the stream may move, providing a variable amount of land to each owner, depending upon the definition of the boundary. It the boundary was fixed at the stream edge at the time of definition, a meandering stream may have real impacts on the riparian rights of each owner. It is quite common for roads to be built along boundaries and for trees to be planted as a windbreak along a boundary. By adding these visible elements to the landscape a boundary may take on an additional organizing part of a landscape.

Changing boundaries

Sometimes, it is quite easy to discover the heritage of a boundary and in other places a boundary may have many different phases to its history as it provides a limit or anchor to ownership or land use. In other places one boundary may a help create a different boundary. A boundary may be created at a certain distance from another boundary to create a visual or functional buffer zone between uses.

Researching the heritage of boundaries can be very immediate and quite easy in some cases where a deed or a Land Court judgement is recorded for posterity and difficult to impossible for some traditional boundaries such as ahupuaʻa. There is no record or tradition that we have found to explain the two parts of the ahupuaʻa of Maowainui separated by several miles and the intervening ahupuaʻa of Naiwa. Often the only evidence of the heritage of a boundary is when it first appears on a map or in the literature.

Maowainui ahupuaʻa

These parts of a line or boundaries heritage are only part of a mapped line's history, but the way in which a line is mapped and moved from one map to another comprises another part of the boundary's history. This series of transformations may actually represent the most important part of a line's heritage, since it is this representation of the boundary that is committed to digital form at some period in its existence. Some boundaries are mapped directly from a field survey, such as an important administrative boundary. Other boundaries are mapped from descriptions such as the ahupuaʻa and others such as conservation boundaries may be defined by an expert interpreting a map and deciding where a demarcation should exist. This type of boundary may become a statute and a legal boundary without anyone ever seeing it or marking it in the field.

Representing boundaries on maps

As has been implied above, there are many different types of boundaries but not all are compiled onto a topographic map. However, more difficult are boundaries that have multiple functions. These are the harder to classify and are sometimes mapped for one purpose and at other times omitted. It is useful to develop a classification of boundary attributes in order to better understand the different milestones in their history and to better be able to characterize their modern and historical functions. The following paragraphs are the project team's working definitions for research although they do not appear in our data base. Since the definitions are subjective, we used them to help organize our research, but felt that coding them in this way in the data base might imply more authority and confidence than we had in some of our research findings.

Boundary types

Legal Boundaries: A legal boundary is one that carries some force of law in one's ability to sell, will, use or transmit the property and the rights to use the land to another person or group. In modern times, such a boundary needs to have it's metes and bounds description surveyed and recorded by some authority. A legal boundary can also be marked or fenced, except in some communities, and aggregated or subdivided according to local statute. The boundary refers to the areal limits of rights of use of the land on the surface and above and below it, unless reserved by some previous condition or waiver or state reserved statute.

Limits of rights

There are many limits to the use of land imposed by governmental and private agencies and one subscribes to the limits by acquiring land under those jurisdictions. Limits imposed after the fact of ownership are subject to legal challenge, however, the boundary is firm unless an incorrect survey or improper description can be demonstrated.

Determining the location of a legal boundary

The legal boundary of a parcel of property is often shown on large scale cadastral maps and used for compilation of other smaller scale maps. However, unless dictated by some legal statute, the official boundary of the property must be established by a licensed surveyor and recorded in a title or deed to the property. The line on any map does not carry any legal meaning, it is just considered a graphic representation of the legal description.

Tax Map Keys

However, large scale cadastral maps are used to compile other maps. And whether the boundary represented on the them is legal or not, it is used to represent parcel boundaries on different scale maps, usually only the larger land holdings. In Hawai'i, before property transactions had to provided to the various county governments in digital forms, the Tax Map Key (TMK) representation of parcels was widely used for analysis and compilation to other smaller scale uses. The TMKs were generally considered the most reliable sources for many types of compilation, although many errors can be found in them on careful inspection.

In Hawai'i, TMKs have only sparse survey control represented if any, which makes fitting parcels to other information limited to fitting street representations to other compilations. In some cases the TMKs are used in compiling topographic map boundaries but usually only for large government land holdings. This practice is changing very quickly as large governmental GIS systems now are holders of parcel information registered to survey control and other classes of landscape information. However, lines compiled from TMKs and other graphic sources continue to exist on our topographic maps and need to be identified as specifically as possible.

Building political boundaries

Political Boundaries: Political boundaries such as city boundaries, except in Hawai'i which does not have such municipal organizational units, county boundaries, and other composite boundaries are assembled from other primary legal boundaries or pre-date them. A political entity is usually defined as comprised of an assemblage of a number of parcels. In this situation, the political entity boundary shares the limits of legal boundaries of its constituent parts. There are cases where political boundaries cross legally bounded parcels splitting parcels into two states, counties, townships, or other jurisdictions. However, in these cases, the legal boundary takes precedence.

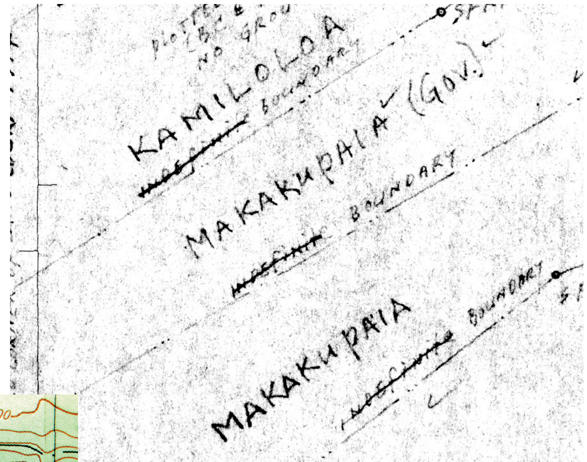
The ahupua'a as a political boundary

In Hawai'i, as mentioned earlier, the ahupua'a forms a basic and what can be considered a traditional but also a political boundary, developed at a time where a different set of political constraints applied. Locally, the ahupua'a predated all other boundaries in the islands. When the process of dividing the land started in the Mahele of 1848 and continued into the Kuleana Acts, the basic unit was the ahupua'a and as individual claims were filed and granted, they were organized within the ahupua'a unit.

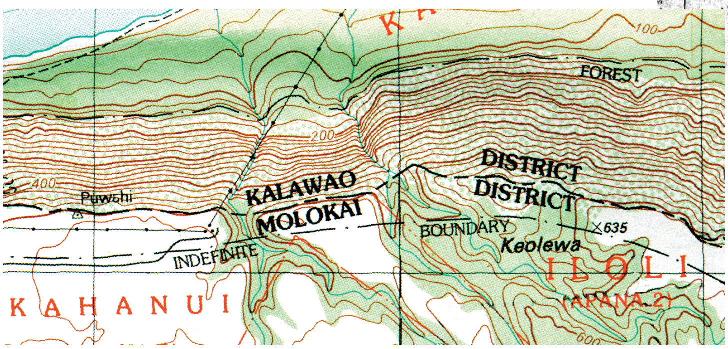
Hawaiian political boundary hierarchary

Hawai'i's political boundaries, affected by a long tradition, have a different hierarchy than in western societies. It's a modern hierarchy that in some ways runs parallel to traditional land groupings. There is nothing that can supercede the island in an island state. Kamehameha unified the islands in 1810, but there were still island to island differences in political organization that persist until today. The current political structure in Hawai'i is State, Federal, County, and parcel, roughly paralleling the Island group, Island, Ahupua'a, Lele, and Ili traditional political structure.

In modern Hawai'i, parcels and political units cross ahupua'a boundaries and ahupua'a boundaries have disappeared, but this political unit has a continuing influence on the all of the subsequent boundaries, especially on Molokaʻi and it is the major constituent of the administrative layer on US Geological Survey topographic maps.

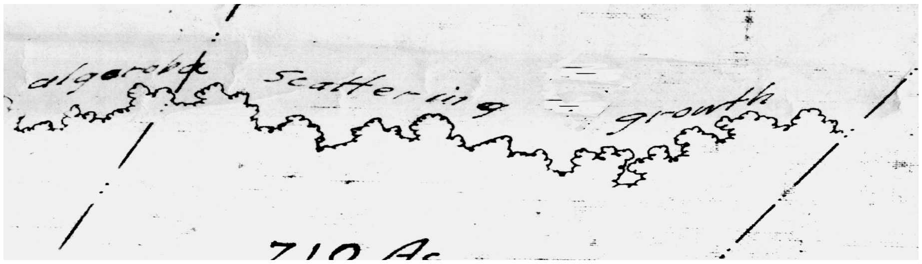


Indefinite Boundaries: Topographic maps include boundaries of the administrative class that are labeled indefinite. In general these are modern demarcations that have been drawn on map without the benefit of a land survey, yet they carry administrative weight. The compilers of the 1983 topographic series for Molokaʻi quite rightly classed many of the ahupuaʻa boundaries as indefinite, but the USGS removed this apellation on the final printed form of the map.



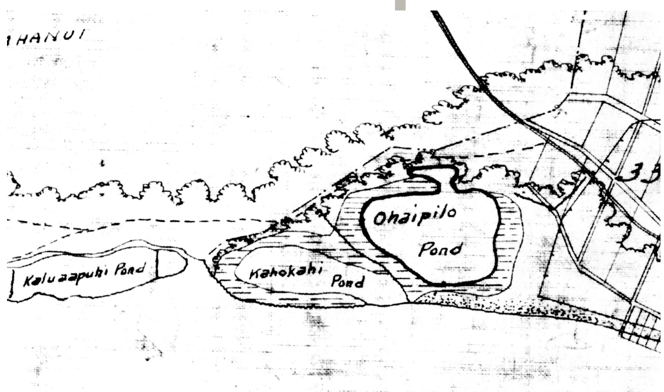
On Molokaʻi, the boundary of the National Historical Park is an example of such a boundary. It was developed by creating an setback from other ridge top parcel and political boundaries in some areas of development potential to prevent any building right at the ridge line that could be seen from Kalaupapa. On other islands, similar statute lines have been drawn on maps to mark the lines between different type of development and conservation zones.

Physical Boundaries: The most common physical boundary is the demarcation land and sea. The line changes with the tide, season, and weather. The US Geological Survey considers this line a cadastral boundary for the purpose of creating a closed polygon for the land part of cadastral units. They includes them on the administrative layer of the DLGs made from the 7 ½ minute topographic maps and code them as a coastline. There are other boundaries associated with water such as swamps and flood plains, however probably the most common physical boundaries are derived



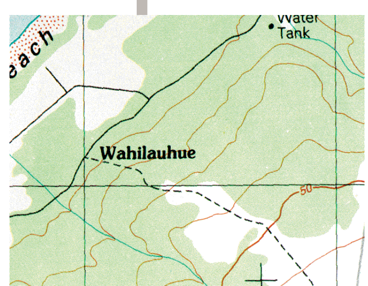
from terrain features. In Hawai'i the cliff and ridge tops are important to the definition of ahupua'a.

In the traditional world, the ridge tops that defined the ahupua'a were well understood and obvious but when the surveyor's began to describe the ahupua'a, they often drew straight lines from feature to feature that crossed or omitted some of the detail of these lines. When Monsarrat's work was compiled onto maps derivative from his, his straight line surveyor legs were redrawn to fit the terrain and better fit the ahupua'a concept.



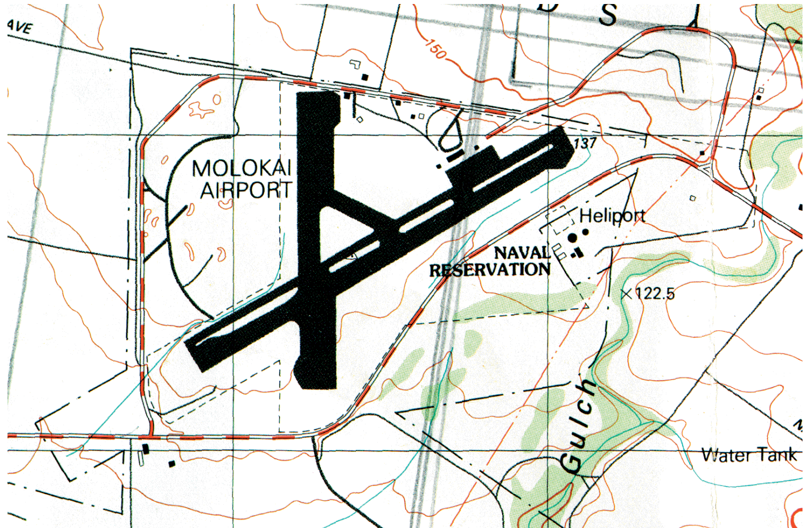
When Monsarrat first mapped Moloka'i, he also included very important vegetation lines that were very distinct lines on the landscape. His maps include the vegetation lines that bounded the coastal vegetation and the line that was the limit of upland forest.

Most of the boundaries discussed above have some meaning with respect to land use or appearance. Many are quite visible on the land, but there are other land designations that carry different types of associations.

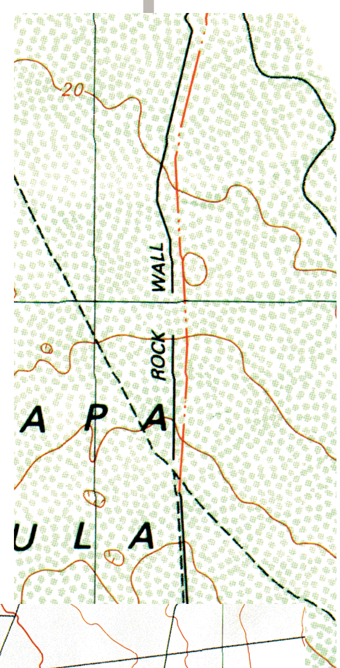


Informal Boundaries: For the sake of completeness, there are other boundaries, or zones of demarcation, that have significance but often do not appear on maps as a cadastral line. In some areas, topographic maps have area names on them that do not have distinct boundaries but which do carry local and traditional meaning. On Moloka'i, there are many traditional area names which are not currently associated with settlements or specific uses. Many people still exist that could draw a line around the area that these names are associated with, but have never had a formal boundary.

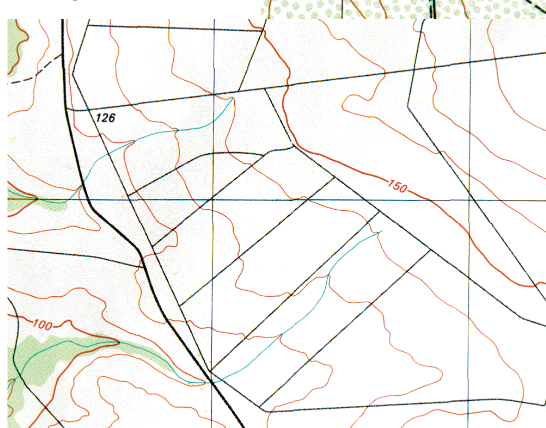
Nested administrations: The administrative layer on Moloka'i is complicated in some areas by boundaries that has one administrative layer imposed upon another with no real difference in functional use of the land. The runways, runway approaches, and part of the parking area of the Moloka'i Airport is demarcated as a Naval Reservation and the ruins of military housing still exist just outside of the airport but not in the Naval Reservation line.



In some places the boundary of the Moloka'i Airport is on the other side of the access road and in others extends further out on the runway approaches and into agricultural land. In other places, the boundaries are coincident. In some places the Airport boundary, particularly in the east, coincides with the Territorial governors designation of an "Airplane Landing Field" before 1918 and in other places it differs.



Land Lines: There is another class of line on topographic and other maps generally termed land lines. These are lines, generally cultural in origin, that form a prominent part of the landscape and contribute to an understanding and visualization of the landscape. These lines are often associated with current or past boundaries, but more than just representing boundaries, they often represent different land associations. On Moloka'i, there are rock walls represented on the maps. Also common on Moloka'i are field lines, where agricultural associations are strong visual elements on the landscape, sometimes these fields are bounded by access or industrial roads, routes that are smaller than would be represented in the normal road classification.



In all of these cases of lines demarcating associations, ownership, a functional regions, whether they are drawn only on the map or exists only in the minds of people, they are a part of the heritage of Molokaʻi. An important element of the philosophy driving this investigation was to explore as much of the heritage of these lines, in the limited time available, and with a very limited staff. The heritage of a boundary tells of its origin its function and its role in modern society, at least at the time that it was represented on the map and possibly converted to a digital file.

In all of the searching involved with trying to understand and classify the pattern of administrative lines on Molokaʻi as represented on the 7 ½ minute topographic maps, the staff of this project constantly tried to find ways to delve into the heritage of each line and draw reasonable conclusions about their history.

OWNERSHIP OF BOUNDARIES

In the study of the heritage of boundaries, a very useful piece of information is the person or agency that is the steward of a common boundary. In practice, normally one group that a boundary is created for will assume or accept maintenance of a boundary. Some cases are obvious. On a fenced boundary of a military reservation, the military unit will usually build, maintain, and sometimes patrol the bounding fence. In some cases, the agency that surveys the boundary will take stewardship or ownership of the boundary.

A broader audience

In some cases such as an indefinite boundary, no-one may take an active interest in the actual ground expression of the boundary. If a boundary was fenced, such as the case of Molokaʻi Ranch, we assumed that the Ranch was the "owner" of the boundary. However, as the research in the project progressed, we found that in many cases it was difficult or impossible to determine the ownership status of boundaries, without a long interview process which was not possible here. Yet the concept is interesting and would make an interesting study in another venue.

DATA ACCESS

The project staff decided from the outset that there was a general interest in the data that we would develop and it should not be left buried in a report. Even though the data are incomplete, given time constraints, we wanted what we did manage to find about the heritage of Molokaʻi administrative lines to be available to all.

Interactive access to the database

One of the final products of this project is an Access data base of our findings and notes. This data base was developed in a relational form so that searches could be conducted. We think that this data base, other than being the basis of feature-level metadata will probably be of more interest to the general public and researchers than to professional users.

However, we also have a goal of general education in mind with this project. Studies have shown that the broad body of map users have a very inflated impression of the accuracy, both positional and classificational, of the printed map, especially those produced by official sources. In making information available about each of the lines on a topographic map, we hope to educate the average user about the real nature of compiled information and its reasonable applications.

We have chosen an interactive map published on the web to make the data generally accessible. There are two forms of the map available, that will be described in detail later in this report. One is a map that will allow direct access to the full data base and another is one that gives a synopsis of the boundary information and includes graphic material relating to the visual aspects of the boundary.

In preparing these data we compiled information about boundaries in the broadest way possible. When we encountered an interesting element about a boundary, we added another field to our data base. The sum result is that many of the fields in our data base are empty since we could not find or follow up on parallel information for all boundaries. However, the philosophy of the project was to explore the concept of feature level information as broadly as possible rather than to constrain it in any way that might lose data that might be of interest to someone.

Methodology

Searching for a Mapped Line's Heritage

METHODS OF RESEARCHING A LINE

Boundary Line Records

At face value, researching the meaning and definition of a line on a map should be very straightforward task. One normally would go the tax office or whoever locally holds the legal description of the line and obtain a copy of the metes and bounds or public land survey system description and the data on the surveyor and the date is was established. There are several reasons why this is problematic with the lines shown on a topographic map and in particular lines shown on Molokaʻi topographic maps.

As mentioned in the beginning lines of the Executive Summary, lines on maps are compiled lines, lines that were copied and scaled from earlier maps or photographs. The question becomes which map was used to compile the lines and what were its special accuracy characteristics. This is particularly difficult to resolve in Molokaʻi since there are effectively two different families of USGS topographic maps that might have been used for compilation.

Compilation series of Molokaʻi topographic maps

All of the topographic maps before the 1983 series were compiled from each other on subsequent revisions, however, the US Geological Survey decided that given the fact that the surveying control used to stereographically compile the maps of Molokaʻi was inadequately surveyed, it was advisable to redo the topographic mapping from the ground up. Therefore, the 1983 and any subsequent revisions are new compilations. Given the thousands of topographic maps prepared for the United States over the years, it is understandable that the Geological Survey does not have perfect records of the sources of information employed in making all of their maps.

However, in the case of Molokaʻi, there are extant records of the administrative compilations which were very valuable in the project. There is a degree of discretion about what lines are actually chosen to be included on a topographic map. The original compilations were done locally but the US Geological Survey does not necessarily include all the locally compiled data. It is also impossible to include all parcel information on a topographic map because of scale limitations.

Traditional ahupuaʻa in the present

In Hawaiʻi, the ahupuaʻa information, the main class of administrative information on the topographic series is especially problematic. As was mentioned in the Molokaʻi chapter, the ahupuaʻa boundaries, critical to the governance of traditional Hawai'i, have maintained an important impact on current cadastral mapping. In brief the traditional ahupua'a boundary was pivotal in the several mahele laws dating from the 1850s because the original division of the land was based on widely known and understood ahupua'a boundaries. As land was granted by the Land Commissions, the imprint of property, especially property located adjacent to the ahupua'a boundaries, effectively defined an unsurveyed boundary.

During the Mahele and the Kuleana Act period, most of the ahupua'a boundaries were described in metes and bounds terms for the Boundary Books, which still reside in the vaults at the Hawai'i State Surveyors Office and in the State Archives. However, the early forms of descriptions were made without the benefit of trigonometric monumented control. Since the ahupua'a were largely defined by terrain features, when trigonometric control was introduced in the 1870s, it was often placed on the same features at the boundaries between ahupua'a. When surveyed, the control was located to fit the ahupua'a boundaries, thus locking their location into the Western survey system. The surveying methods of the 1850 to 1870 period were less refined than those of the present, but the property boundaries were real existing boundaries testified to by people working the land according to their definitions established in the Mahele, and sometimes by building fences.

Ahupua'as and territorial survey control

As newer and more refined surveys gave better metes and bounds to the property parcels, often a parcel boundary which was originally on an ahupua'a boundary, could gradually move the ahupua'a boundary from its traditional location based on modern surveys of the property boundary. The first detailed mapping of the ahupua'a boundaries on Moloka'i was Monsarrat's series of three large-scale maps, based on field surveys, informants and the newly established territorial government control stations.

Monsarrat's first Moloka'i mapping

These maps were done before there was any local concern for datums and the shape of the earth which is now the basis of our cadastral mapping. The result of refinements in survey methods was a shifting of the location of ahupua'a boundaries from their original locations on Monsarrat's maps as datums were adjusted and control markers resurveyed. In West Moloka'i, the carefully surveyed boundary of Moloka'i Ranch follows a set of traditional ahupua'a boundaries. However, when the Ranch boundary metes and bounds surveys are plotted on the US Geological topographic map base created from Digital Line Graph (DLG) information, the Ranch boundary is considerably displaced from the administrative layer ahupua'a plots.

Variable ahupua'a lines

Why is there the discrepancy? Although the traditional boundary has not moved, its expression has. The ahupua'a boundary plotted on the current topographic maps was compiled from Monsarrat's work and the Molokaʻi Ranch boundary is compiled from parcels located along the original boundary. This is why heritage information about boundaries is so important when trying to locate where the boundary really goes.

WHICH AHUPUA'A BOUNDARY DO WE USE TO TRACE HERITAGE

In order to develop a starting point for the administrative map line heritage, we need to decide which representation of the lines are going to be used. In itself, this question is not without confusion. One could easily say, of course, the line on the topographic map, but we live in a digital world, and the digital forms of the map lines are considered much easier to analyze than graphic ones so we are already several steps away from the printed form of the map.

1983 series boundary compilations

To answer this question, we need to trace how the administrative lines are processed by the US Geological Survey from compilations to map form to the digital form that is present in so many GIS data bases. In the 1983 series, the US Geological Survey contracted with a local surveying firm, R.M. Towill, to prepare the compilation for the administrative boundaries on the Molokaʻi sheets. These compilations were drawn on scale-stable materials and annotated and submitted to the USGS along with compilation reports. Luckily these reports have survived in the USGS archives in Rolla, Missouri.

These compilations contain more information than appear on the final form of the maps, and were valuable data in tracing the heritage of the lines. The information on these compilation materials will be detailed later in the chapter.

1983 map finishing and storage

In the 1983 procedure for preparing topographic maps, the compilation sheets, after editing, were transferred to a scribing material and draftsmen prepared the final map reproducibles that were used in preparing the printing plates for the maps. In addition to printing plates, the scribed originals were used to make other intermediate copies. The original scribed or negative engraved separations were transferred to photographic emulsions for storage since the original scribed materials tended to become brittle with age. These photographic separations were then composited into a single black and white photographic film for a number of different purposes.

Photographic data storage and digital conversion

Both the photographic film positives of the separates or layers and the composites became very important in transferring the mapped information to digital form. Data in pre-digital days were archived in film form since it was a close as possible to scale-stable: (its graphic representation did not change size as drastically as paper during storage and environmental fluctuations). Because of the large number of topographic maps in production and revision in the United States, thick base photographic film was the only feasible alternative.

The scale-stable separates were originally produced to archive data in a way that it could always been made to fit together - register - if the original map printing plates were worn out before the next revision. However, their scale stability was to prove very important in the digital revolution. It was this series of materials that provided the first media for manual tablet digitizing of topographic map information into a form amenable to GIS application.

NATIONAL MAP ACCURACY STANDARDS

Spatial accuracy of topographic map data

The precision with which graphic information is presented on topographic maps is governed by the National Map Accuracy Standards (NMAS), first developed in 1941 by the Bureau of Budget. Generally considered the weakest of mapping standards in the Western world, they do provide a framework for classifying the relative accuracy of information on different scales of topographic maps. The standards relative to cultural information specify that well-defined information (including administrative boundaries) shall be represented on 1:24,000 topographic maps no further than 40 feet from their true position in 95% of the tested cases.

This value provides a relatively large margin for error but probably considered quite reasonable for the planning and inventory applications anticipated for 1:24,000 topographic maps when the standards were devised. These standards were subject to all manner of exceptions related to the design and symbolization of cultural information on the actual printed map. However, when the maps became the main source for digital conversion, the NMAS created many problems for digital applications.

DIGITAL LINE GRAPHS

Spatial accuracy of digital map files

Since spatial data could be easily converted to digital form at a far more precise level than was graphically possible a few years earlier, the softness of NMAS and all of its exceptions became a thorny problem in digital data. Although a new standard is now in preparation for digital data, NMAS did not carry over to digital forms of data captured from the graphic forms of topographic maps. This was simply because the first digitizing of topographic maps was done by manually tracing the lines on the scale stable photographic film forms of the topographic maps with a hand controlled cursor. While almost all of the work done in this way was quite good, including most of Hawai‘i’s digital data, it still was a manual process that could not help but degrade the already weak standards that applied to the original data.

Later in the digital conversion process, digitization of the scale-stable sheets moved from the composite film positive of the maps to the separates. This transition to scan digitized separates provided much more consistent results. Hawai'i, largely because of its size, was the first state to have complete coverage of digital data in the form of Digital Line Graphs, and its data were captured in the manual method.

Different modes of digital conversion of topographic maps

The fact that Hawai'i was very early in the digitizing program had another effect on this project. In the first digitizing procedure conducted with film positive composites, the data were structured in a way that was quite different than is done later in DLG conversions. Digital lines were comprised of a string of points, vertices, that were aligned along the graphic line and began and ended at a point of a different type called a node. Nodes are very important to GIS applications because they signal a type of change of state for the attributes of the line.

In modern scan digitizing of a single class of information, a line between two ahupua'a will be comprised of a beginning and ending node a large number of coordinate points or vertices in between. When data were digitized from a composite sheet, an ahupua'a boundary could easily cross many other lines in its extent, perhaps ten roads, four streams and a several other administrative boundaries. Every time the ahupua'a boundary crossed another line, a node was inserted, thus breaking the ahupua'a line into many segments. These intersections created a great deal of manual work on this project just reassembling the segments into functional boundaries.

DIGITAL LINE GRAPH CODING

Each line or arc as the string of points between two nodes was classified in the USGS system with a series of codes, major and minor. Problematic from the start, it was done manually and often by people not familiar with the regional differences in the country. Line coding is a set of a three digit major code, followed by a three or four digit minor code were necessary. Since the DLG conversion process was begun in the late 1970s, there have been a number of changes made to the line codes. From the beginning of coding, the Hawaiian land tenure system has proved a source of confusion for the mainland coders, resulting in many of the lines in the early DLGs of Hawai'i being left blank or mis-coded.

Major and minor DLG codes

In addition when the standard US Geological Survey ASCII format DLG was converted to the Spatial Transfer Data Standard DLG, other changes and re-interpretations were made. In the USGS DLG format the data per quad were broken up into Nodes, Areas, and Lines. Only Areas and Lines were coded. In the early data the only way that a line could be coded was as (1) a boundary closure -- coastline; (2) a coincident line - a boundary that was coincident with another feature or line or (3) an indefinite boundary.

Coding lines versus areas

On the administrative DLGs, areas were surrounded by sets of lines and they could be described by strings of major/minor codes. In the first DLG set, areas on Molokaʻi were classed as (1) civil districts; (2) national parks; (3) military reservations; (4) state parks; (5) state forests; (6) local parks; (7) ahupuaʻas; or (8) homestead land.

The table below represents the most current boundary coding system in effect with dates of changes noted where known.

Current USGS DLG feature codes

```
000 0000 Outside area
090 0000 Photorevised feature
090 0001 Boundary monument
090 0002 Boundary turning point
      Deleted before 1/85
090 0100 Civil township, district, precinct, or barrio
090 0101 Incorporated city, village, town, borough,
      or hamlet
090 0103 National park
090 0104 National forest
090 0105 National wildlife area
090 0106 National wilderness area
090 0107 Indian reservation
090 0108 Military reservation
090 0109 Nonmilitary government reservation
      Deleted before 1/85
090 0110 Federal prison
090 0111 Miscellaneous Federal reservation
090 0112* Non-National Forest System lands
      Added 07/95
090 0113 Land grant
      Deleted before 1/85
090 0114* Forest Administration Area
      Added 07/95
090 0115* Forest Service Ranger District
      Added 07/95
090 0116* Land owned by Forest Service but outside of
      proclamation       boundary
      Added 07/95
090 0129 Miscellaneous State reservation
090 0130 State park
090 0131 State wildlife area
090 0132 State forest
090 0133 State prison
090 0134 Miscellaneous county reservation
```

```
090 0135 Ahupuaa (Hawaii)
      Added 10/90
090 0136 Hawaiian homestead
      Added 10/90
090 0150 Large park (city, county, or private)
090 0151 Small park (city, county, or private)
090 0197 Canada
090 0198 Mexico
090 0199 Open water
      Added 10/90
090 0200 Approximate boundary
      Deleted before 1/85
090 0201 Indefinite or approximate boundary
090 0202 Disputed boundary
090 0203 Historical line
090 0204 Boundary closure line
090 0299 Processing line
      Added 10/90
090 0301 Reference monument for boundary point
091 00-- State or State equivalent FIPS code
092 0--- County or county equivalent FIPS code
093 00-- Civil township or civil township equivalent
      FIPS code, first two digits
      Added 10/90
094 0--- Civil township or civil township equivalent
      FIPS code, last three digits
      Added 10/90
095 ---- Monument number
096 XXYY Alphabetic portion of any monument number
      Added 06/87
098 0000 Best estimate of classification or position
      Added 06/87, Deleted 07/95
099 00-- Coincident feature
      Deleted 10/93 memo (05/94 Standard)
```

Adding and redefining line codes

The Moloka'i Project was concerned with boundaries more than the areas that were created by them and all the codes normally split between lines and areas have been assigned to lines and additional data base fields have been created to specifically identify the areas on each side of a line. These data (1) line segments numbered by the US Geological Survey and (2) USGS assigned codes that were collapsed from line and area sections to the lines represented the starting point of the data set.

LINES, FEATURES, AND BOUNDARIES:

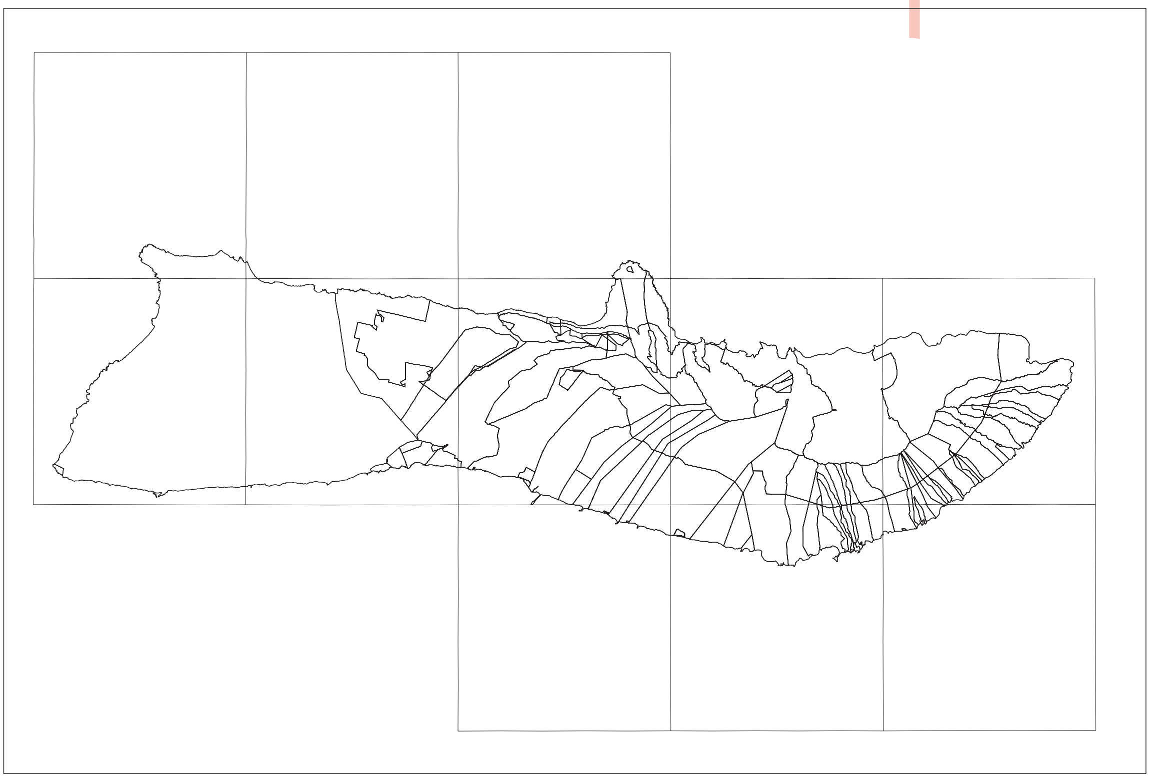
Line aggregation

The DLG data on Moloka'i were aggregated first from USGS line segments to features "functional line segments" and then to boundaries, administrative units of the 'one to many' coding type. It is with the boundary unit that the heritage search begins. However, the ability to search into the data set cannot be based on the boundary unit alone, so a much more complicated structure must be maintained. For example, if one needs to search for all of the ahupuaʻa of a certain class of survey definition, backward links must be maintained as well as forward ones so that that degrees of accuracy can be traced to the source material.

Multiple boundary attributes

This structure only maintains the identification links. The actual coding will be open-ended depending on what is found in the heritage research. A boundary has a number of attributes that are applied differently by users in different fields. First, a boundary, by definition, separates spheres of jurisdiction or influence. This attribute of a boundary has been particularly difficult in the Molokaʻi Project since part of the boundaries on the DLGs have been coded according to what they separate and part have been coded by their meaning --- and part remain un-coded by either factor.

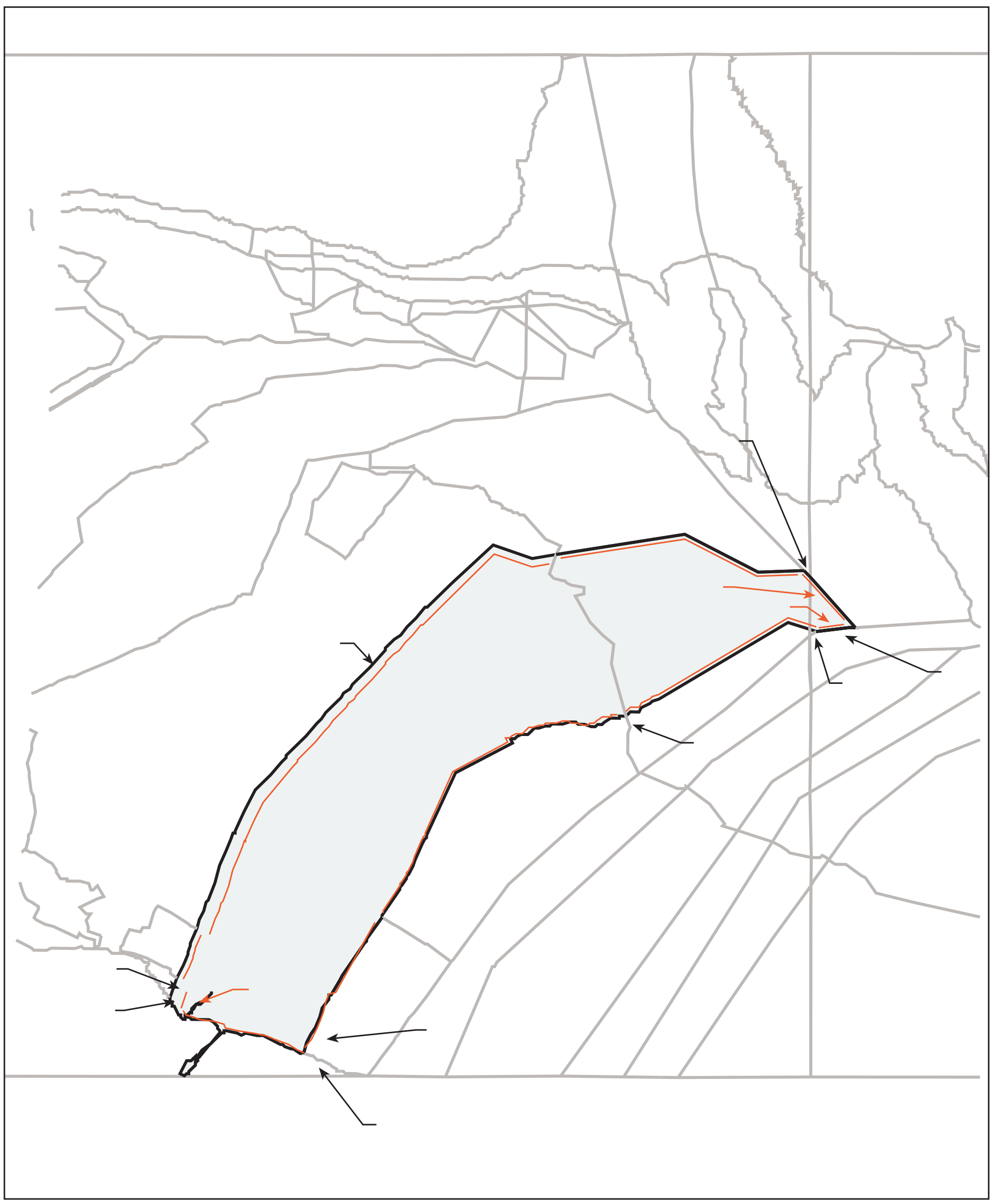
Building the data structure



The lines that represent the basic unit in the DLGs may not represent single features or boundaries. Therefore, the line structure of the raw data needs to be aggregated in a manner that will ultimately develop into features, the basic unit of this analysis. In the original USGS data, lines are identified and coded, often with multiple segments, within 7 ½ minute tiles. For some lines, the original line corresponded to a functional boundary, while in other cases a boundary was comprised of a number of individual lines. It was apparent that the nodes that broke some of the boundaries represented the intersection of lines on the original source topographic map and in other cases were nodes where the number of points exceeded some standard number of digital points.

7 1/2 minute quads and tiles

The staff did not want to modify the original data set in any way, and we also did not want to modify the USGS coding of the lines that originated in the Digital Line Graphs. In addition, since the coding of the lines were internal to the 7 ½ minute tiles that approximated



Cross tile lines

the original quad locations on the islands, we did not want to add an additional layer of coding in order to assemble the tiles into an island-wide system. However, an island-wide system was necessary since boundaries obviously could be expected to cross the tile-edge lines.

There is, in effect, a unique coding of each line implicit in the tile system when the quadrangle name is included in the description. The letter that indicates the tile code can been seen below on the Kaunakakai illustration where the Fnnn and Gnnn lines are assembled into features and boundaries.

In Hawaiʻi, quads are often oversized in either a north-south direction or an east-west direction to better fit the irregularly shaped islands. On Oʻahu, the quads were offset from their even 7 ½ minute grid fit so that there were fewer quads that were comprised of 80% or more ocean. When the USGS decided to standardize on a 7 ½ minute tile approximating the older system, some cumbersomeness was added to the original naming. The xxxxxxx quad on Molokaʻi became the xxxxx tile and the xxxxxOE-N (over-edge north) tiles. To simplify this for the purpose of our data base structure, we substituted a simple lettering system for the tiles that could be associated with the tile names and codes with a lookup table in the data base. Therefore, line 349 on the Halawa-OE-S tile became K349, the base unit in the data structure.

Lines into features

The next level of integration was to assemble the lines into features, the basic unit of our metadata. Features are defined as a linear structure that connects nodes that collects three or more lines. Therefore, where two boundaries cross, four lines will enter the node that defines the end of a feature. Where a boundary meets a coastline, three lines will enter the defining node. A feature is a unique element of all boundary lines in that it has a single structural meaning. However, features are the building blocks to the data structure. A linear structure that serves to separate a Forest Preserve and a National Park unit has two functions. It serves, with adjacent features, as a Forest Preserve boundary for part of its length and a Park Service boundary for another part of their assembled length.

Feature 109 above is aggregated from lines F61 and F102. However, one of the most tedious jobs was to assemble the boundaries with their often overlapping functions. In this case the shaded Kaunakakai ahupuaʻa above was then assembled from features 125, 127, 128, 129, 109, etc.

Features into boundaries

The boundary is the most aggregated linear structure in our data base and would be the starting unit for many types of queries. It is on this issue of the boundary that the project staff disagrees with USGS and standard GIS coding of lines. Lines are coded by the USGS as being the edges of areas or polygons and not given a coding of their own. Their codes must be deconstructed from the polygon coding. In some cases, lines are coded with their functional attributes, apparently giving these lines a different, but confusing meaning in the hierarchy of importance. In effect, it was this differential coding, assumed by many to be source of much confusion, that initiated the Moloka'i Project. We agree with the GIS topological considerations which require that lines be coded with which polygon's are on the right and left side of the line, however, the line / feature / boundary can and usually does have an implicit meaning related to its derivation that is much beyond the meaning associated with being the simple edge of a polygon.

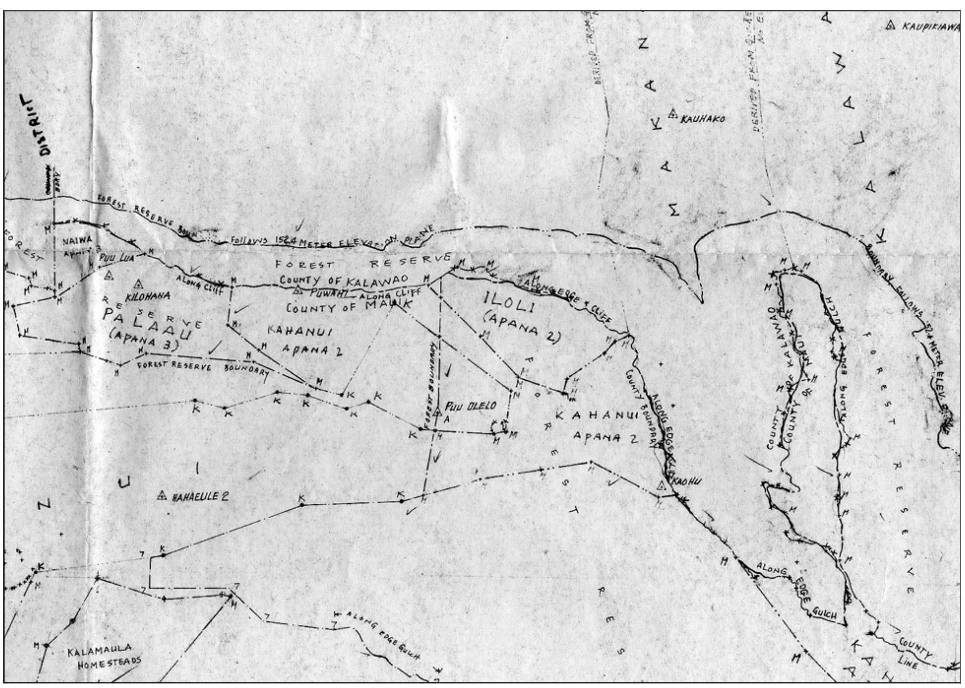
Area and line coding

Therefore, project staff coded features and boundaries, thus describing implicit meaning and associated heritage and accuracy as an entity. We feel that ignoring of the defined meaning of a linear feature is diffusing much of the meaning of the "cartographic line" and its compilation heritage, in favor of the area orientation of the GIS technology. Losing the meaning of the line by the USGS method of coding is a serious loss, one that we will attempt to counter in our feature-level metadata.

SEARCHING FOR LINE HERITAGE:

Anecdotal and documented data

There are two main approaches to developing line heritage information. One is documented evidence, which is unfortunately rare,

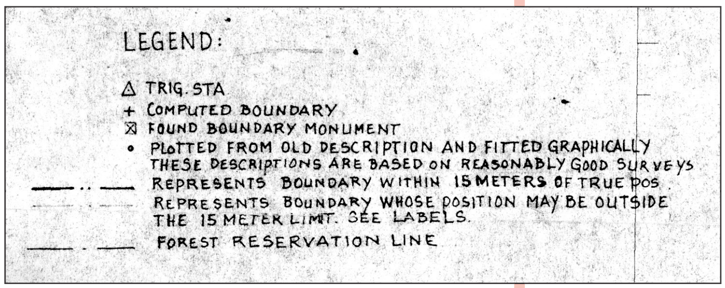


but usually the main source of information. The other is to locate anecdotal information from people involved in the mapping process or who were familiar with the project in some way. Obviously, anecdotal information, in almost all cases, deals with recent projects. And even with recent work, one cannot exclude documents because there is very often conflicting evidence.

Because of the varied sources of information that appear on Hawaiʻi maps, especially related to the traditional land division systems, a wide range of sources need to be consulted. The most important starting point is from within the records of the US Geological Survey itself.

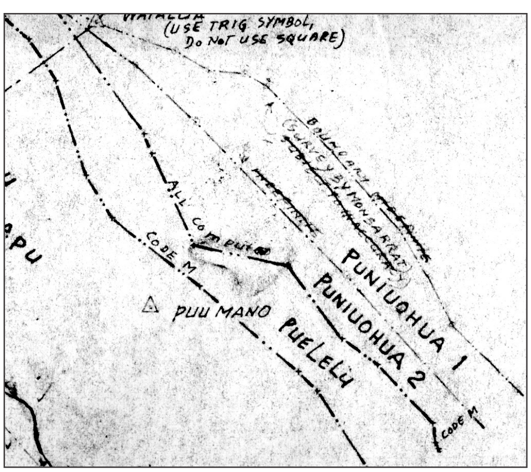
US GEOLOGICAL COMPILATION RECORDS:

When a topographic map is newly made or revised, copies of the compilation sheet at scale and a written record of the process are kept on file for a period of time. Luckily in the case of the 1983 Molokaʻi sheets, these records were still available and the USGS was willing to provide copies for our reference. These compilation sheets are done for the different levels of map information either internally or by contractors in the area. Done on scale-stable material, and intended for direct transfer to the topographic map plates, these "Boundary Plots" were blueline copied and provided to the staff along with "Field Completion Reports" that were prepared by the contractor for USGS review, including an outline of the compilation methods and sources and comments about the relative accuracy of the sources and the resulting plotted lines.



Boundary plots

The boundary plots include further information, in some cases feature by feature data, that provide more information about the relative accuracy of the lines. However, all lines are not so detailed. Segments of the blueline copies of the compilation sheets for Molokaʻi quads are included to illustrate the wealth of infor-



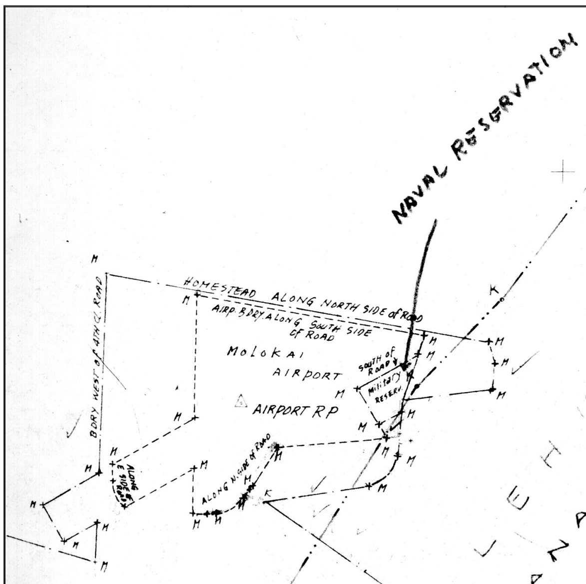
mation available. The importance of these data sources to the development of metadata cannot be underestimated.

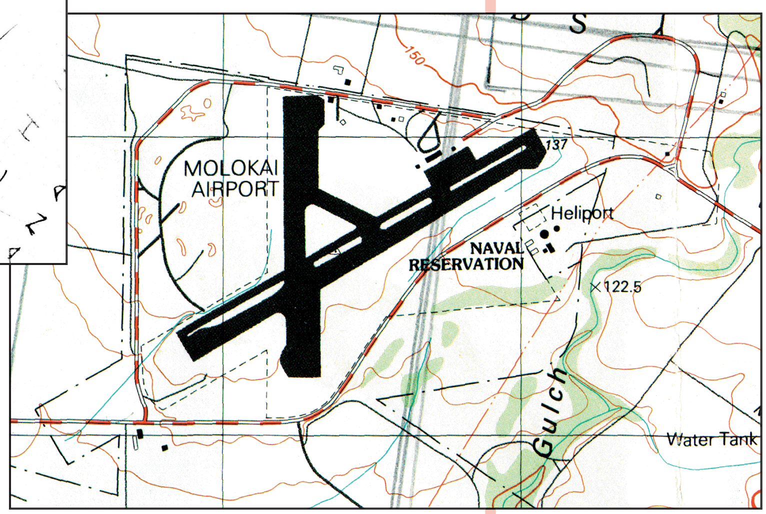
In some cases, the boundary plots provide information that is more clearly presented than the final plot of the information on the topographic map. Compare the interpretation of the location of the Naval Reservation associated with the Moloka'i Airport on the two representations that follow.

In the case of some ahupua'a the source material is made very clear, information important to a compiler from Hawai'i but apparently not a part of the design specifications of the administrative layer and it was lost when the map was finished.

Field Completion Reports

While the Boundary Plots contain a wealth of metadata information about specific features, the Field Completion Reports prepared for each quadrangle contain a different level of data. These Reports contain information much more related to anecdotal rather than documentary heritage data. Reproduced below are several sections of these Field Completion Reports as they related to specific classes of information in the administrative layer of the topographic maps. A full copy of the Kemalo Quadrangle completion report is included in the Appendix for reference purposes.





Variable Ahupua`a Data

As has been noted, throughout this report, the ahupua'a boundaries represent a special problem on Hawai'i topographic maps. The compilers of the Boundary Overlay encountered the same problems as this project's staff in attempting to trace individual boundary heritage. It was not possible to simply reproduce the compiler's notes on the Boundary Overlays since their information was incomplete. As important as these boundaries are to Hawaiian culture, there is no single definitive reference source.

The ahupuaa boundaries on this quadrangle required a disproportioned and inordinate effort in document research, field investigations and in the compilation on the boundary overlay.

Hawaiian Homelands

The USGS did not take the compiler's advice on Hawaiian Homestead land and continued to plot these boundaries, however there are a number of problems with the representation of these boundaries, especially in the northwest part of the saddle.

Survey Quality

The note of Robert Pease's surveys below has roots in some mapping histories. With careful study of his metes and bounds descriptions in the "Boundary Book" in the State Surveyor's office, the nature of some of the problems can be noted. Much of his work was redone later by M.D. Monsarrat and shows major acreage discrepancies between the two surveyors. In order to understand some of the reliability differences between surveys and surveyors, it is useful to go to

[redacted]

primary sources such a field notebooks. In addition to Mr. Monsarrat's detailed field books preserved in the Hawai'i State Surveyor's Office, Monsarrat kept detailed diaries that adds very valuable information to the more formal field notes. However, it is very difficult to find any primary personal information about Pease and his contemporaries'

Certain boundaries are lacking reliable documentation or field evidence and should not be considered for publication and are omitted therefore. To this category belong also all boundaries described or made by Mr. Pease, a Surveyor General of the 1860 period.

Moloka`i work, beyond bills for services in the State archives, yet a stigma remains attached to his work.

As can be seen, the Boundary Plots or Overlays and the Field Reports provide some information on the sources of data that appear

> b. From metes and bounds descriptions primarily prepared by or based on surveys made by M. D. Monsarrat, a contract surveyor for the Territory of Hawaii before and around the turn of the century. These metes and bounds surveys are mostly related to still existing triangulation stations (which he had established) and which were integrated into the USC&GS triangulation net lateron. These metes and bounds surveys were plotted at a suitable scale and reduced photographically to a scale of 1:25000 and matched to the plotted triangulation stations. Some were

on the topographic map administrative layer, but only in a variable way, not consistently identifying heritage down to the feature level. In addition, the Boundary Plots also give considerably more valuable information than appear on topographic maps and DLGs, information that would be very valuable to the creation of a detail metadata. However, this information, used by the map compilers, does not find its way into the final map.

STATE SURVEYOR'S OFFICE:

Since most of the boundaries that we were researching are determined by local agencies, one of the most fruitful areas to begin is in the archives of the Hawaii State Surveyor, who by statute maintains the records of publicly funded surveys and surveys of state land. In Hawaiʻi, this office is very important because of the state's small land area and short state history. This office concentrates the most important records relating to governmental surveys of both the territorial and state periods.

Some county agencies will also hold administrative boundary records, but in conjunction with the State Archives, research into ahupuaʻa heritage must begin in these two agency offices. Many of the records associated with counties are also found here because of the island-by-island work conducted by governmental agencies before statehood and the increasing administrative importance of counties. In the Hawaiʻi, as valuable as the State Surveyor's Office is, it is one of the most difficult sources to plumb for two reasons. First the maps and records stored in this office are only poorly indexed, and there is no publicly accessible index of records. The knowledge of the records contained here are largely in the minds of the staff. Each staff member, depending on their time in the office and day to day experience, has a different mental index, especially where linkages between data sets are concerned.

State Surveyor's Office

Second, because of the age and fragile nature of the archives, there is no public access to the materials except through office staff, and if the staff does not fully appreciate the type of research that is being conducted, as good and helpful as they are, they might not comprehend that the next map in the drawer would be even more valuable than the one that you requested to study.

Data Access

As staff retire or move to other agencies or firms, unfortunately, their mental indexes move with them, requiring new staff to begin again and learn the system from their peers. If there is one archival need in the State of Hawaiʻi, it is for all the records in the State Surveyor's Office to be microfilmed and properly cross-indexed for historical and geographical research.

There are four general areas of information that need to be consulted for map heritage research in the State Surveyor's Office.

Fieldbooks and Compilations

Historical Records: In the last half of the 19th century, a great effort went into preparing, manual copies of records and reformatting them in many different useful ways. Most of this work in the Surveyor's Office were done by staff of the period who were intimately familiar with the personnel and the problems of the existing materials. These compendiums are useful since the people who prepared them often offered editorial comments, made corrections to earlier work, and unfortunately sometimes, confused issues and introduced their own errors as well. Anyone working with Molokaʻi must start by requesting the "Molokaʻi Books", volumes of meticulous hand written text and sketches about the different types of surveys and their results. These books (thin ledgers or school essay books) are extensively cross referenced to earlier work that has sometimes disappeared or was not in the original collection. However, when the referenced work is available, this research route is the most efficient way or organizing the search.

The Moloka`i Books

In some cases, these summary books may be the only source of information. The only record that we could find of Pease's land descriptions were copies that appeared in the Molokaʻi Books. Other historical records also exist in the State Surveyor's Office. Some of the most valuable were the diaries of the State or contract surveyors. In particular, Monsarrat's diary of Molokaʻi work carried a great deal of information about the island and the people who assisted him.

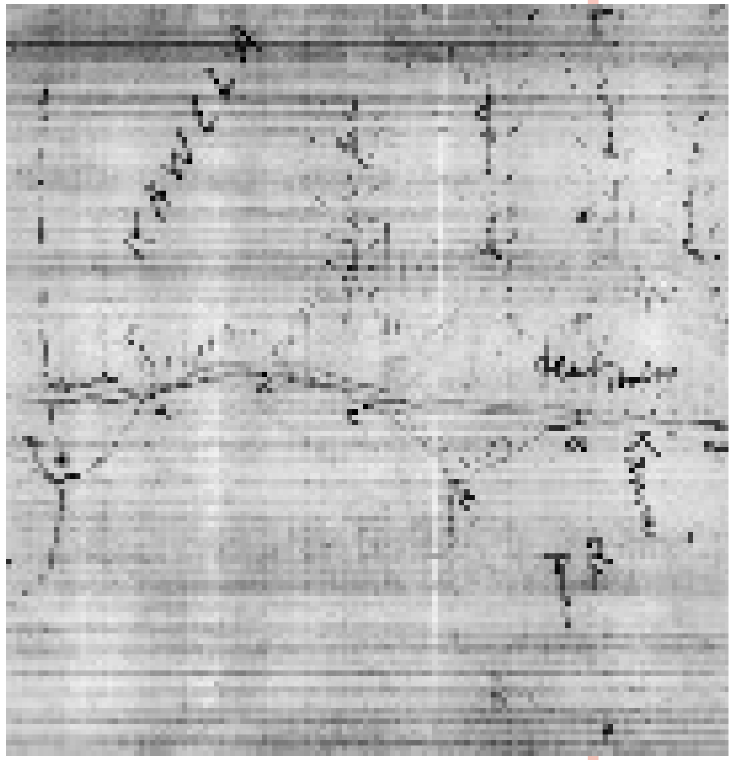
Monsarrat's Diaries

Of crucial importance was the original survey notebooks and especially the sketches that accompanied almost every page of notes. Surveyors have always been taught to include sketches in their field books to identify the relative location of points and objects in their surveys. Some surveyors are better than others in this procedure.

Field Sketches

In point, Monsarrat's books were particularly well illustrated. He included much more detail on his records than is common. He made notes about placenames, people who assisted him in the field and other comments about his field days.

Map Files: While we expected to find important materials in the State records of all the boundary surveys, we did not expect to find as much information in the historical records as we did. Because of the importance of the ahupua`a to Hawai`i surveys and land tenure, we went back to the earlier surveys to track the heritage of these traditional administrative lines. There are few early maps of the ahupua`a on Moloka`i except for what appear in the Moloka`i books, mentioned earlier. These maps were more sketch representations rather than maps drafted from field notes.

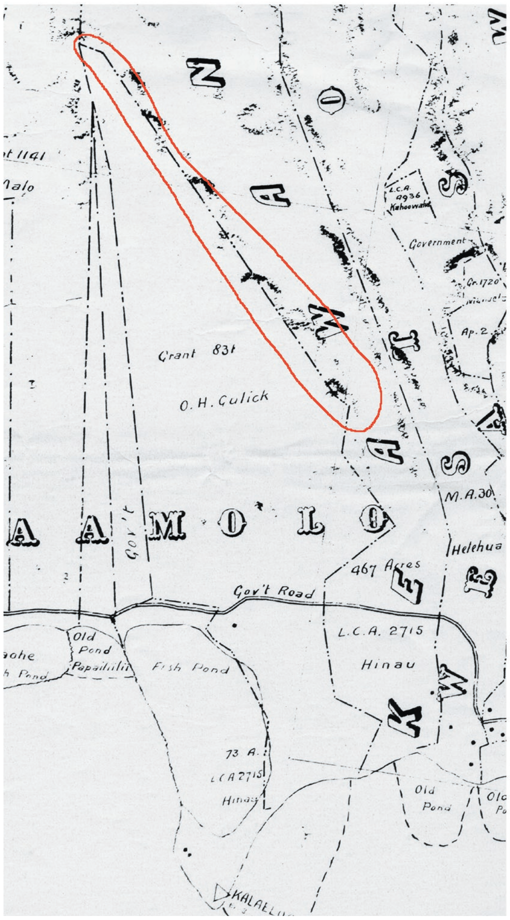


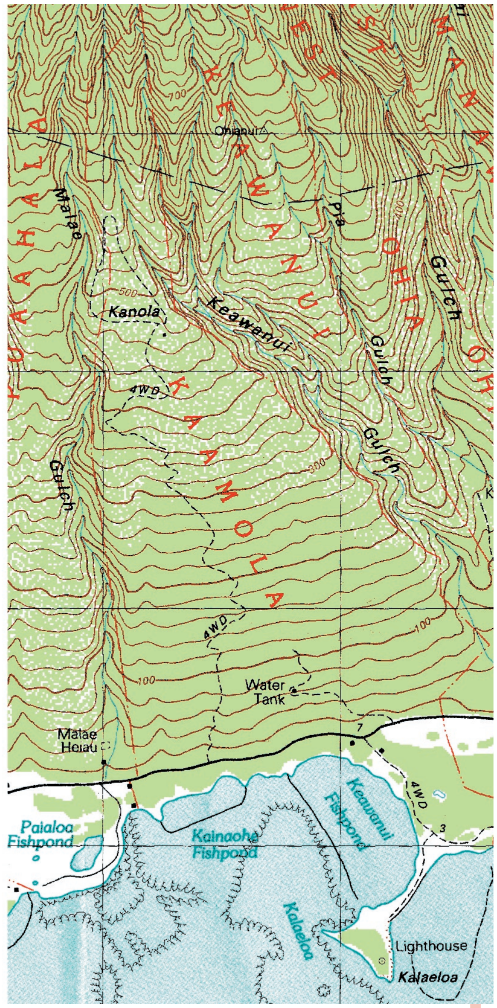
The first really valuable maps in the historical record were those prepared from Monsarrat's surveys from 1894 to 1896. In addition to being the first large scale maps of Moloka`i, they were the first to incorporate both trigonometric control which was tied to the ahupua`a representations. The value of these drawings was appreciated by the compilers of the 1983 series of topographic maps of Moloka`i as they noted in their compilation records that they were consulted in their work.

The First Monsarrat Maps

However, there are some differences in the ahupua`a representations on the current topographic maps and those on Monsarrat's map series. In standard surveying practice, Monsarrat completed his traverse along ahupua`a boundaries by shooting from point to point along a ridge edge. In a traditional ahupua`a, the boundary would follow the topographically defined ridge edge.

The compilers of the 1983 series obviously took Monsarrat's work as a starting point and generalized the boundaries into a better mapped representation of the nature of the boundary. Note the red circled boundary of the ahupua`a on the Monsarrat map and compare it to the USGS topographic map representation of the same boundary. The USGS compilers followed the ridge while Monsarrat plotted it as a straight line. In addition there is also a discrepancy between the spelling of the ahupua`a and how the ahupua`a is closed





on the north end of the boundary.

Modern surveys in the State Surveyor's office provided a different type of information about the metadata of the administrative boundaries represented on the 1983 maps. While inspecting some of the current maps based on the Digital Line Graph forms of the 1983 mapping, particularly of the Molokai Ranch boundary, there appeared to be some rather large discrepancies between the location of the boundary according to current surveys and that shown on the DLG forms of the boundaries, all of which were based upon the same ahupua'a data.

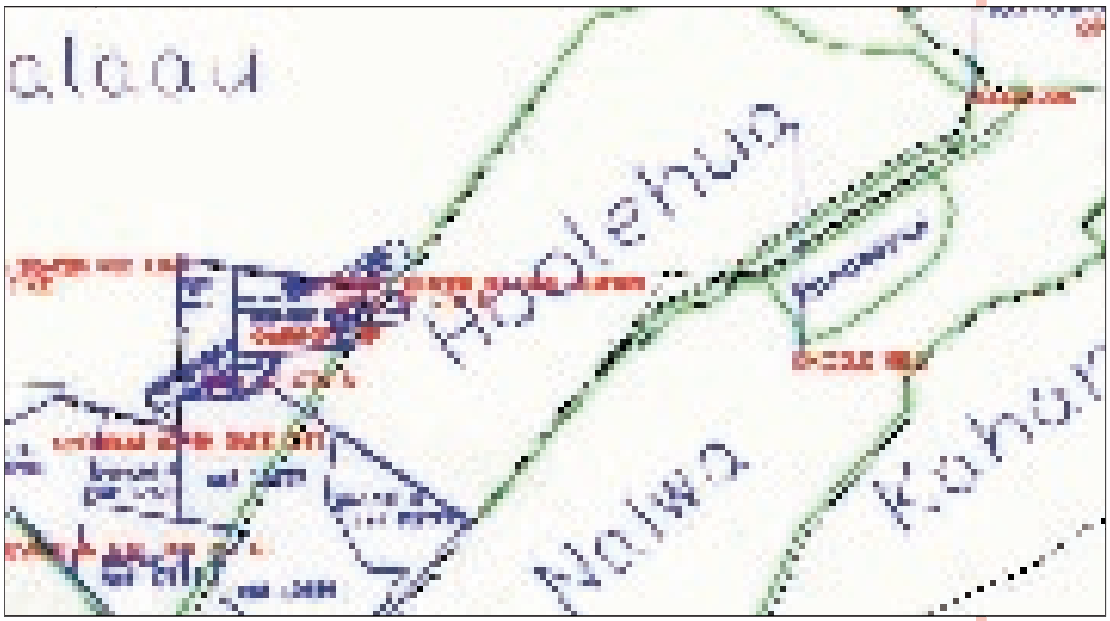
Back to Metes and Bounds

Replotting sample data

Noticing discrepancies in many situations, the staff took a boundary description approach to resolve or at least track down the source of the differences. One staff member with extensive experience in title work and land descriptions did some sample work checking the mapped ahupuaʻa with their descriptions. While the scope of this project could not allow the recompilation of each boundary, we felt that it would be very useful to investigate a sample of the ahupua'a and other boundaries represented on the topographic map administrative layer.

Replotting selected airport boundaries

In this approach, we acquired boundary descriptions from a number of sources in Hawai`i State and Territorial Government. We worked from ahupua'a descriptions from the boundary books, from the title descriptions of large land parcels and from several state parcels near the airport, to try to provide an independent check on a sample of boundaries. These data were plotted in AutoCad using the title metes and bounds values starting from the control points referenced in the land descriptions.



We were concerned at first with the appearance of an boundary error in the vicinity of the Manowainui ahupua'a by the double lines that separate it from Ho'olehua ahupua'a northwest side of the boundary. Further investigation showed that the double lines are in fact correct, although we could not trace the reason for the strange duplicate alignment. When the lines were replotted from their metes and bounds descriptions, there was considerable variable offset and angular deviations in the boundaries of the area, but not all lines were misplaced which seems to rule out a general data shift. The DLG lines compiled by the USGS are shown in blue and the green lines were plotted by the staff. On the average, most of the lines sampled in the airport area showed less than a 15 meter difference between the replots and the mapped respresentations which is within the National Map Accuracy Standards.

HAWAI`I STATE ARCHIVES:

The Hawai'i State Archive materials are organized in a very different way than are the materials in the State Surveyor's office, and while there is some overlap in areas such as ahupua'a descriptions as contained in the boundary books for each island, there are many other types of information that are useful in tracing boundary line heritage.

The State Surveyor's office holds the plots of many of the boundaries solidified as a result of the Mahele and the Kuleana Acts. It is important to inspect the original documents related to these Acts, because they are located along with the surveys from the applications in the State Archives. In a separate area are maps from a variety of sources, often cataloged only by year if no other attribute is obvious. For the most part, the State Archives do not have formal collection policy, therefore their archives and files are formed by the contributions of many different agencies and individuals. Because of this somewhat random nature of the map collection, finding materials valuable to a heritage search can be serendipitous, but there are some very interesting materials in the collection that, while do not explain the final or current status of a boundary, do give some information to the processes that lead to the current boundarys that have been found.

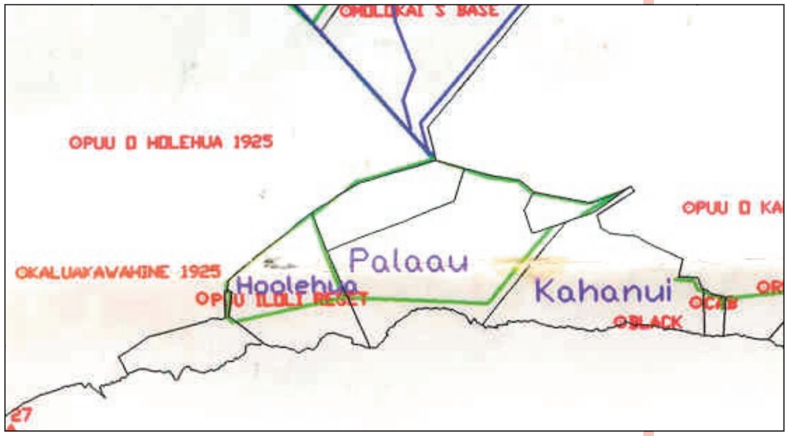
Researching the Surveyors

The State Archives is the home of many conventional sources of information like the Mahele books, Land Court Awards, and Boundary files. There are some other forms of information that can be valuable to tracing the heritage of lines. One class of information that we found valuable was the "name" file. Knowing that a line that was described by a specific surveyor, the name file catalog's the location of that individual's name in all of the context's that the Archives have cataloged. These leads can provide information about other aspects of the surveyor's private and professional life that can provide interesting insights into the man's field operation and devotion to his trade. These files obviously can also be used to lead to the activities of other players related to the land or its measurement.

OTHER SOURCES OF HERITAGE CLUES:

General Library Searches can sometimes yield information indirectly related to map boundary lines though descriptions and historical notes about people who were involved in the different types of land actions that create or modify boundaries. In one area on the south shore of Moloka'i where current mapped shoreline and ahupua'a boundaries differed considerably from the first Monsarrat series, a history of Molokaʻi Ranch described an aggressive reef-filling program that changed both the shoreline and the nature of the coastline.

The shift can be seen on the accompanying map where the plotted seaward ahupuaʻa boundaries of Hoʻolehua and Palaʻau show the amount of fill that happened between the Mahele and the turn of the century.

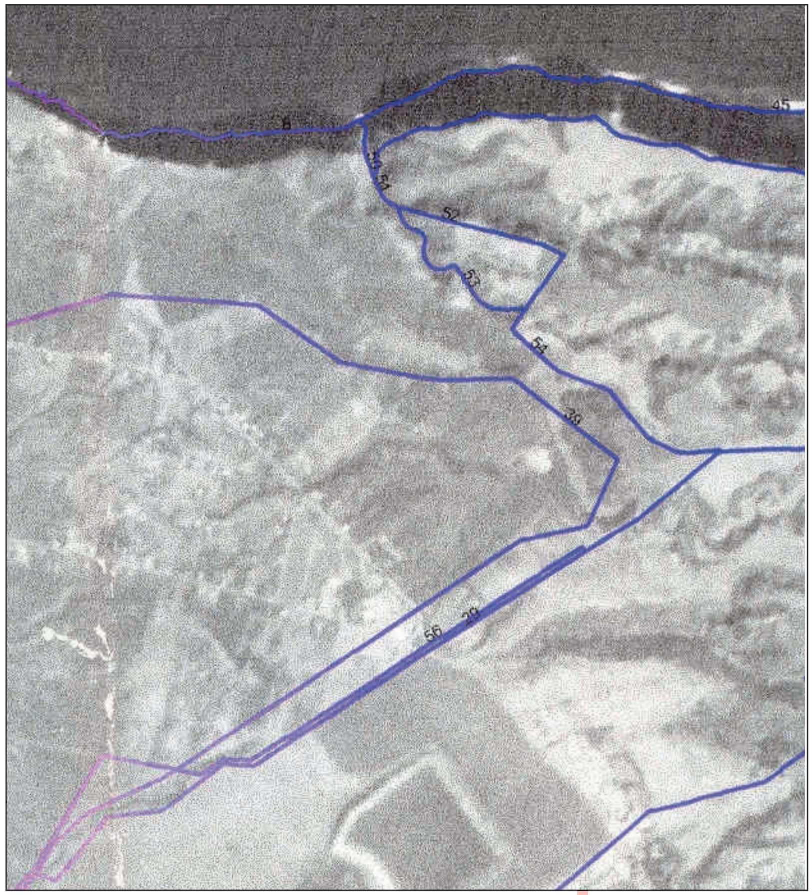


An analysis of several regional and Moloka`i histories provided a range of clues about the historical events and processes that shaped the formation of the boundaries that are the subject of this report. However, a number of the boundaries were difficult to trace to their origins, even with extensive searches in conventional sources. In addition to local histories, other types of books and articles can provide useful heritage information. There have been a number of books on mapping and surveying activities written about parts of Hawaiʻi as well as histories of surveying progress and techniques that use local examples that also can be useful.

Regional history, Travel diaries, and Surveying history

In a different light, collections of older map series can be very useful in providing clues to line heritage, especially series done by different agencies or by different techniques. When a map is a revision of an earlier series, there is a tendency to make new or documented changes, but unless a complaint has been received, older work is let stand unchecked and unchanged, even though it might incorporate some error.

Photographic evidence: Boundaries often separate different types of land use that are visible on the ground and different types of imagery ranging from low altitude aerial survey photographs to satellite imagery. Photographic analysis is primarily a supplementary form of boundary analysis. While imaged boundaries are incomplete because all boundaries are not visible, the boundaries that are visible on the photographs can be very powerful indicators of the accuracy of the location of the boundary on the map. On the following scans of 1:24,000 orthophoto images, the administrative boundaries from the DLG layer have been plotted in blue. These black and white images are mainly useful for strong and texturally contrasting land uses.



In general, larger-scale color or color infrared boundaries provide more useful tone and color associations with the land use on either side of a boundary. However, unless orthophotograph versions of these types of photographs are available, boundary matches, or more importantly, mis-matches can be misleading because of the inherent geometric distortion present in large-scale stereoscopic images. Even though this type of photo/boundary matches are of limited use in determining metrics of boundary accuracy by direct measurement, they are of great use in field interpretation of boundaries because of their detail and color resolution.

In spite of their use in understanding administrative boundaries in field interpretation, they have also been known to mis-lead interpreters when land-use changes are not associated with USGS mapped boundaries and when two or more boundaries are nearby. Even with the difficulties associated with the interpretation of stereo photographs, they should be the starting point in any analysis of visual elements of the mapped landscape. From the scale perspective afforded by this type of imagery, even the most subtle of land-use detail and other evidence of human activities can make a strong visible imprint on the landscape.

Supporting information

Field analysis: There is no substitute for walking in the field to gain a more developed understanding of lines on maps. One set of boundaries northeast of the airport on Molokaʻi puzzled the staff from our first analysis. We could not see any reason for this parallel pattern of boundaries.

At first, we thought that there was some kind of plotting error that was not caught in the editing stage. However, the staff visited the site and looked at the boundary set from where a

road crossed the closely parallel set, it became obvious that two of parallel line boundaries and conclude that they are an accurate classification. However, without a long process of interviewing, it would be difficult to explain the functional meaning of the boundaries.

Field checking

Interviews: Physical and documented evidence is only part of the heritage of a boundary. There are usually reasons for the establishment of boundaries, sometimes very personal decisions and preferences are involved. However, it is often very hard to find ways into this realm of boundary heritage. Since the normal revision cycle for USGS topographic maps ranges from 15 to 25 years, boundary location and creation may be decades old. This situation makes it rare to find an individual with detailed knowledge of boundary history. In this research, we found two such individuals, whose personal knowledge of Moloka'i boundaries, could have taken a boundary study into a completely different realm.

Most boundaries are visible on the ground

When researching a relatively recent boundary, one federal employee was able ".... to tell you who drew the boundary, on what basemap, at what time and date, and with what color of pen". One long time state employee had very detailed knowledge and documentation of the forest reserve boundary in up-country. He explained that this boundary periodically changed after the reserve's creation early in the last century. These changes occurred as private landowners placed parcels of their land in the trust temporarily and removed them as their term agreement came due. This man had very detailed records of the actual boundary changes and could anticipate changes some time into the future as land parcels were to enter reserve status.

If these types of personal knowledge on the creation and compilation of lines on maps were recorded for all of the lines on a map and digitally attached in some way, there would be no need for metadata in the very generalized form that it has currently taken.

ACCESSING DATA DETAIL

Layer Metadata

The conventional form of metadata applies one set of characteristics and conditions to a whole data layer. For many types of mapped information, a singular metadata form is unsatisfactory at best because of how many forms of mapped information is compiled. As has been noted several times earlier in this report, each data class of compiled information has quite different metadata characteristics and there are also considerable within-class variations especially in the Hawaiian data layer associated with the ahupua`a land designation.

This inter- and intra-class variation in Molokaʻi administrative data demands an alternate form of metadata, one that reflects the actual nature of the data or at least allows the variability to be recorded. A term that has been used to describe this form of metadata has been feature-level metadata or data about individual features comprised of different assemblages of line segments. In general, feature-level metadata display a much greater range of data than does the very generalized metadata associated with map layers or themes.

Feature-Level Metadata for a Broader Audience

There are a number of alternate ways of classifying feature level data and for accessing the classified data. We chose a data classification that reflected the data available after working on a number of features in the data set. After seeing what data were available and projecting what types of information would be useful to the user community, we chose a data structure that illustrated the information that could be developed for most features. We also discussed the types of information that might serve a broader community who might be interested in learning more about the meaning and background of data on maps. The following list of data elements were the ones that we decided to research.

Data Base Elements

Database Column Definitions -

1. (A)[1] Feature -

It may be noted that not all numbers in the sequence are represented in the final database. This was caused by clean-up, consolidation, and clarification in an active, inter-linked database and does not indicate any deficiency in the data.

2. (B) Line -
3. (C) Boundary -
4. (D) USGS Code - Entries in this column are based on guidelines provided in the USGS Attribute Coding Standards for Digital Line Graphs. All features shown are compiled from the *civil boundary* data layer of the USGS DLGs, and therefore, begin with 090. This is followed by sub-codes:

-0103 National Historical Park
-0105 National Wildlife Refuge
-0108 Coast Guard Base
-0131 Forest reserve
-0135 Ahupua'a
-0136 Hawaiian homestead
-0151 Small park (city, county, or private
-0201 Indefinite boundary
-0204 Boundary closure lines

5. (E) USGS Assigned - This field has two possible entries, *yes* or *no*. *Yes* indicates that the code shown in Column 4 is the official USGS code assigned to all line segments which constitute this feature. *No* indicates that, if a code is shown for this feature in Column 4, it was assigned by the project research team in compliance with the USGS Attribute Coding Standards for Digital Line Graphs.
6. (F) USGS Description - This is the standard description used by the USGS in conjunction with the assigned codes, also taken from Attribute Coding Standards for Digital Line Graphs.
7. (G) Local Description - This column provides additional information regarding the designated feature, including the local name for the feature.
8. (H) Side A - Side A or B has been arbitrarily assigned as an indicator of one side of a feature or the other. It is used to provide information on the name of the land either inside or outside, east or west, north or south, etc. of a given feature. This column is most significant when providing information regarding ahupua'a, for current place names and directions are often the product of use of these names.
9. (I) Side B - Complementary in function to **Side A**.
10. (J) Side A Secondary - Additional information regarding the designation of land to one side of a feature, as when a feature delineates both a portion of the forest reserve boundary and that of an ahupua'a.
11. (K) Side B Secondary - Complementary in function to **Side A Secondary**.
12. (L) Surveyed - The only possible entry in this column is *yes*, indicating that the researchers were able to verify that the feature has been officially surveyed. If verification was not made, the space is left blank, as lack of verification does not assume that the survey was not done

Data Base Elements

13. (M) Date of Survey - If a feature has been surveyed, and the research team was able to verify the date of the survey, it is given here. Early surveys in Hawaii were often conducted over a period of several years prior to the compilation of the data and the drafting of a map, making it inappropriate to extrapolate the date of a specific survey from any known map. In order to provide accurate dates of survey, the original surveyors' field books must be searched and features matched to the specific descriptions provided by each surveyor.

14. (N) Accuracy - This is an indicator of the accuracy of the feature portrayed in the USGS DLG Boundary layer data, relative to data found in official survey documents used to establish these features. Ratings are taken from USGS compilation documents, 1982. Code indications are as follows:

1 = feature within 15 meters of true position
2 = feature whose position may be outside the 15 meter limit
3 = feature indefinite
4 = feature appears to be a mixture of segments rated 1 and 2 over various portions of its extent.

These codes are represented in the compilation documents by variations in *line weight* on hand-drawn compilation sheets. The analysis of this information is being done from blue-line copies of 17 year old documents. While every effort has been made to be as accurate as possible, a caveat concerning the potential for error in this rating is appropriate.

In addition, the following alpha codes have been added:

F = forest reserve. No accuracy rating can be located for these features. Examination of the original 1912 map, shows that the official boundary was noted as a line roughly drawn on a hand-tracing of an earlier map.

N = not found. This feature does not appear on the compilation documents.

S = shoreline. This natural feature is dynamic, continuously changing, and therefore only *relatively* coincident with the boundary closure shown in this DLG layer.

T = topological. This is a feature which follows some topologic construct, such as a ridge line or a gulch, and for which no specific accuracy has been given by the compiler.

15. (O) Date Mapped/Documented - This indicates, for each feature, either the publication date of earliest map or the earliest date for which documentary evidence (i.e., executive order, land court decision, etc.) establishing or verifying the existence of this feature could be found.

Data Base Elements

16. **(P) Visibility -** This indicates that a feature can be seen in a SPOT (Systeme Pour d'Observation de la Terre) image, in an aerial photo, or on the ground. Possible entries in this column include:

S = visible on a SPOT image
A = visible on an aerial photograph
G = visible on the ground. This category includes features visible from offshore.

17. **(Q) Ownership -** Ownership in this case refers not necessarily to the owner of the adjacent property, but rather to the party responsible for establishment and maintenance of the *feature*, such as those features which make up the boundary of the Forest Reserve.

18. **Notes -** This column will indicate if there are notes attached, providing additional clarification or discussion regarding this particular feature. The letter shown in parentheses preceding each column heading is used as a reference.

(Footnotes)

[1] The letter in parentheses is used as a reference in the **Notes** column to simplify coordinated use of the spreadsheet and the notes document.

Tabular Data Presentation: Developing the data elements was only part of the problem associated with the complexity of feature-level metadata. With an intermediate level of data coarseness, accessing the data can represent an number of problems. Since each line

19	4	E26	63	090-0204	yes	boundary closure line	shoreline			4
20	4	D6	63	090-0204	yes	boundary closure line	shoreline			4
21	5	E1	63	090-0135	no	ahupuaa	ahupua'a	W--> Kaluakoi	E--> Palaau	5
22	5	E2	76	090-0135	no	ahupuaa	ahupua'a	W--> Kaluakoi	E--> Palaau	5
23	6	E3	1	090-0204	yes	boundary closure line	shoreline			6
24	7	E17	76	090-0136	no	Hawaiian homestead	Hawaiian homestead			7
25	7	E18	76	090-0136	no	Hawaiian homestead	Hawaiian homestead			7
26	7	E5	76	090-0136	no	Hawaiian homestead	Hawaiian homestead			7
27	8	E19	75	090-0204	yes	boundary closure line	shoreline			8
28	8	F48	1	090-0204	yes	boundary closure line	shoreline			8
29	9	E23	63	090-0135	no	ahupuaa	ahupua'a	W--> Punakou	E-->Iloli, apana 1	9
30	9	E24	63	090-0135	no	ahupuaa	ahupua'a	NW--> Punakou	SE-->Iloli, apana 1	9
31	10	E25	62	090-0204	yes	boundary closure line	shoreline			10
32	11	E42	62	090-0135	no	ahupuaa	ahupua'a	W--> Iloli, apana 1	E--> Hoolehua, apana 1	11
33	11	E43	62	090-0135	no	ahupuaa	ahupua'a	S--> Iloli, apana 1	N--> Hoolehua, apana 1	11
34	12	E41	63	090-0135	no	ahupuaa	ahupua'a	W--> Punakou	E--> Hoolehua, apana 1	12
35	13	E45	61	090-0204	yes	boundary closure line	shoreline			13
36	14	E38	57	090-0136	no	Hawaiian homestead	Hawaiian homestead			14
37	15	E40	61	090-0135	no	ahupuaa	ahupua'a	W--> Hoolehua, ap 1	E--> Palaau, apana 1	15
38	15	E44	58	090-0135	no	ahupuaa	ahupua'a	W--> Hoolehua, ap 1	E--> Palaau, apana 1	15
39	16	E46	58	090-0204	yes	boundary closure line	shoreline			16
40	17	E37	63	090-0136	no	Hawaiian homestead	Hawaiian homestead			17
41	18	E16	74	090-0135	no	ahupuaa	ahupua'a	W--> Punakou	NE--> Hoolehua	18
42	19	E39	57	090-0136	no	Hawaiian homestead	Hawaiian homestead			19
43	20	E27	58	090-0136	no	Hawaiian homestead	Hawaiian homestead			20
44	21	E28	58	090-0135	no	ahupuaa	ahupua'a	S--> Palaau, apana 1		21
45	22	E33	57	090-0136	no	Hawaiian homestead	Hawaiian homestead	Palaau Homesteads		22
46	22	E29	59	090-0136	no	Hawaiian homestead	Hawaiian homestead	Palaau Homesteads		22
47	23	E30	57	090-0136	no	Hawaiian homestead	Hawaiian homestead	Palaau Homesteads		23
48	23	E31	57	090-0136	no	Hawaiian homestead	Hawaiian homestead	Palaau Homesteads		23
49	24	E35	56	090-0135	no	ahupuaa	ahupua'a	NW--> Palaau, apana 1	SE--> Kahanui	24

Tabular Data Access

aggregate or feature has a geographic reality, simple tabular presentation of the data about a feature masks very important elements about the location of a line or often as important, the location of a feature relative to other associated data. For this reason we chose to develop a graphic query data system based on the features themselves in place on an interactive map.

The extreme variability of the administrative data situation on Moloka'i complicated experiments in designing a method to serve both for data base access and for adding graphic information, so that a better understanding of the data might result. We decided early in the project work that to present the data in a data base or tabular form would discourage all but the most hardy in finding any element that was necessary to one's administration. Conventional overlay levels of metadata are tedious enough to work through, but a feature level metadata present in ASCII or tabular form was rejected as impractical.

In order to make this experiment more than just collecting detailed line data, these data needed to be communicated or a system put in place to that would allow the information to reach the widest range of potential users. From the outset of the project, it was considered critical that these data be made accessible to the public for them to search a range of functions beyond the mere classification of metadata.

Planning for Interactive Access

In the years of the project, there have been a number of technological changes that have affected the final form of the data base. In the beginning of the project while collecting data, we searched for alternative methods of presenting the data. Considerable time was expended trying to develop a relational data base that would allow queries from a number of different elements of the data base. This data base was built on the different classifications of lines discussed earlier, however, we did not want to have the user need data base software for queries. In the end, after considerable development time in data base development, we rejected that approach except for in-house data management.

Relational Data Base Elements

Graphic Data Access: We felt that the best solution for users would be some sort of interactive map. Preferably a map that would allow interaction with the relational data base directly, but the cost of the existing software was prohibitive for the limited funds available for this pilot project. In the time since this decision was made, other options have come onto the market but there are still high acquisition costs for the software and annual maintenance fees that require on ongoing infrastructure beyond the scope of this project.

Alternate Types of Graphic Data

In the end, we decided to experiment with one form of data base access that would allow web inspection of the data base rather than full relational interaction. In its current form, one of the methods of accessing the project data is to identify a line on the interactive map which then opens an abbreviated form of the data base for an element listing. However, we felt that this type of interaction was useful for some types of users but others would not find this type of detail to be valuable.

From the outset we wanted to have graphic information in the data base, because images would help to explain the nature of the ground expression of mapped lines. We spent time searching for data bases that could access image data, but in the end decided on a more easily maintainable form of graphic access that would serve the users who might better like to explore the nature of Molokaʻi in images rather then text.

Different Types of Users

While exploring options for data access, we categorized different types of potential users and the associated types of data access that they might most use: In this analysis we settled on four major types of data base use. (1) Professional Decision Making; (2) Map Use Education; (3) Cultural and historical education; and (4) General metadata record keeping.

Professional Users

In the Professional user category, we anticipated users who would consult the data base for data accuracy purposes relating to how a certain feature, or class of data, should be used in compilation of or registration of it to another type of data set. We would expect this type of user to need to know the heritage and age of a line such as the State Forest Reserve boundary in the area of a type of vegetation zone under study. Such a person might wish to know the if an apparent difference in forest type is associated with the different types of land management on either side of a Reserve boundary in the period when the forest was last thinned.

Map Interpretation Users

The second application arising from our academic orientation is the function of Map Use Education. Studies have shown that there is widespread misunderstanding (or total lack of knowledge) of map symbols. To have a publically available detailed key to topographic information might serve an important role in increasing the understanding of maps as a data and decision making tool. To see that a prominent map boundary created in the late 18th century is associated with a major type of land use might trigger the broader understanding of the function of boundaries and their implicit accuracy.

Cultural History Applications

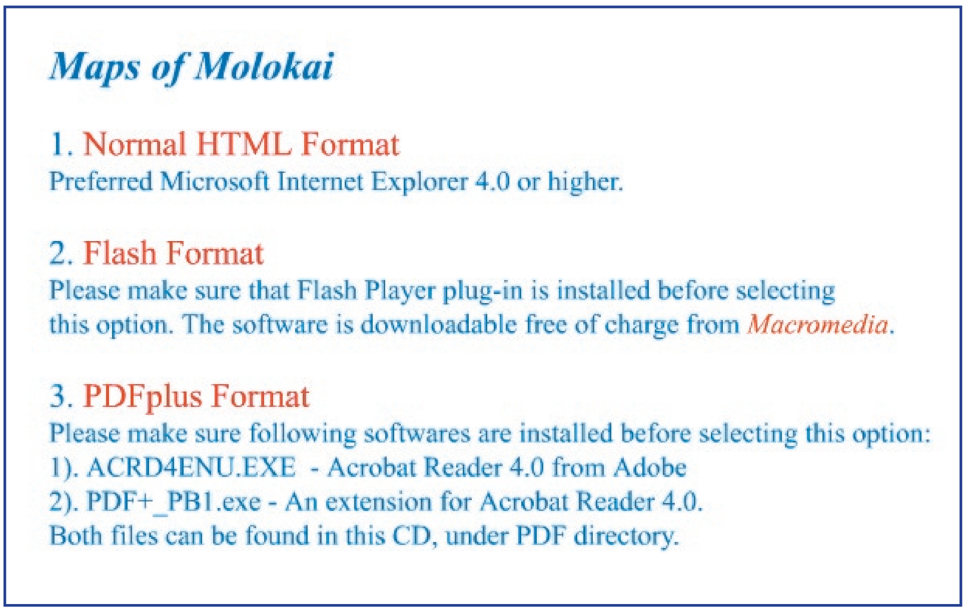
In Hawaiʻi and in particular Molokaʻi, many of the land boundaries are ahupuaʻa boundaries which carry cultural and political significance. To have an easily accessible data source that documents the name and history of the boundary, when or if it was surveyed and by whom, and its role in modern boundaries would be of value to many types of users ranging from local residents to historians. The last option for data access, to function as a repository of metadata, is obvious and necessary.

WEB Access of the Data Base: The staff felt that given the advantages (and disadvantages) of the Web, it was the best and most convenient venue for storing the feature level metadata for all functions and users. The almost universal access to the Internet and its highly developed graphics, is particularly attractive for this type of information. However, some of the features that we wished to incorporate were not universally available on the common web-browsers. This necessitates downloading some special plugins for general use.

The design of the Interactive Data site began with the development of a selectable map of Moloka'i. This was done in several stages, and while the concept was straight-forward, its actual production was difficult because of the nature of the boundaries on Moloka'i. To satisfy the special needs of all of the anticipated users, there are three versions of the interactive map.

A Demonstration of Graphic Access

On the CD supplied with this report, open the system html browser, **Netscape** or **Internet Explorer** and open the introductory home file "index.html" in the main directory of the CD. This file will open a selection screen that offers three different ways into the data



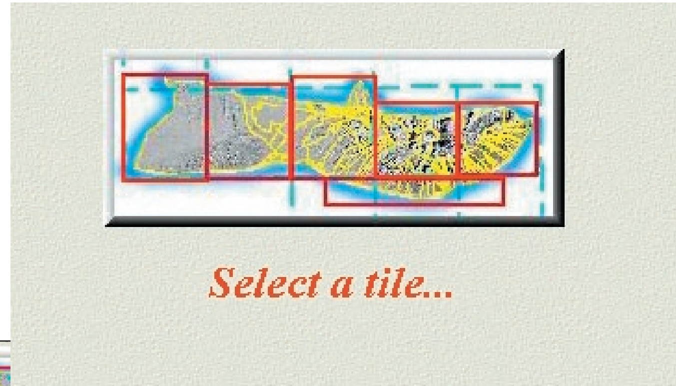
set and any plugins that might be needed. Each of the plug-ins are included on the CD that is included, and may need to be installed on a host computer to complete the demonstration.

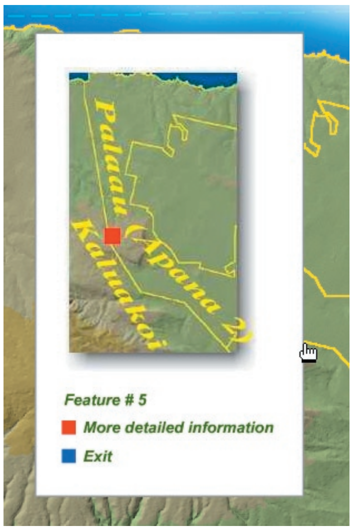
Opening index.html on the CD will open a welcoming screen entitled Maps of Moloka`i. Each of the options were designed to meet a different need and access the metadata in a different way.

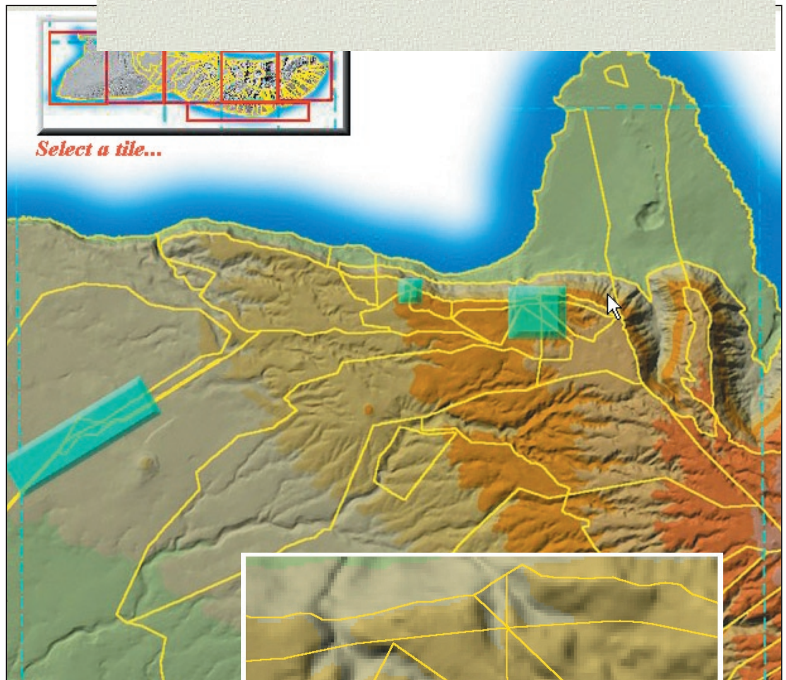
HTML Data Access

Normal HTML Format: Choosing the HTML option will open a thumbnail of Moloka`i tiles. Choosing a tile will open a largerscale image of the tile with the features displayed on a hypsometric shaded relief of the island. In several places shaded green boxes are located as inset indicators where particularly complicated sections of line-work are located. Clicking on one of these boxes will open an inset of the area.

Selecting a feature with the mouse, either from the inset or the base map, will open an enlarged page with an annotated line and an option for more detail. Selecting "More detailed information" will open another level of infomation where available.





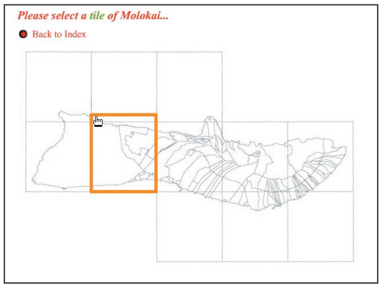


Feature 56

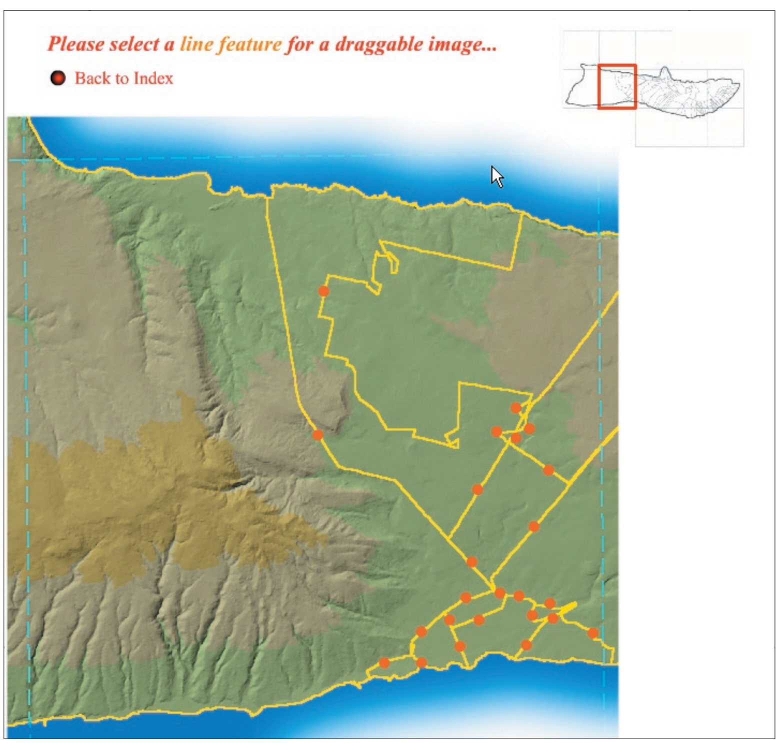
Hawaiian Homestead boundary. The boundary exhibits an uncommon easement like offset from the adjacent ahupua`a boundary, placing it completely in the adjacent Palaau ahupua`a. In the photograph, the boundary fence line and the Naiwa boundary follows the tree line to the left.

FLASH Format: When the FLASH option is selected from the Maps of Moloka`i screen, a different form of the tile selecter is displayed. When a tile is selected, a larger scale verstion of this tile is displayed similar to the HTML version. However, in this case, red target dots are displayed for selecting the lines.

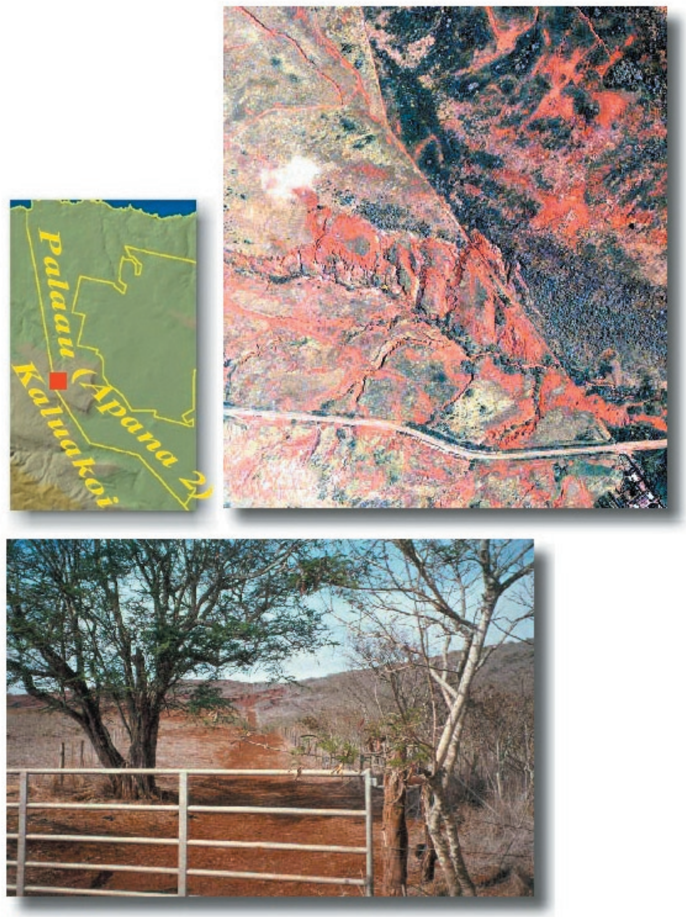
Macromedia FLASH Data Access



When the mouse cursor is in the select range, the dot pulsates and when the feature is selected, an inset is displayed with the feature number and an option to select more detailed information, the same as in the HTML version. If "More Detailed Information" is selected, a larger panel is opened with images and descriptions. This panel is the same as the information content that was accessed in the HTML form of the map.



FLASH Data Selector Map



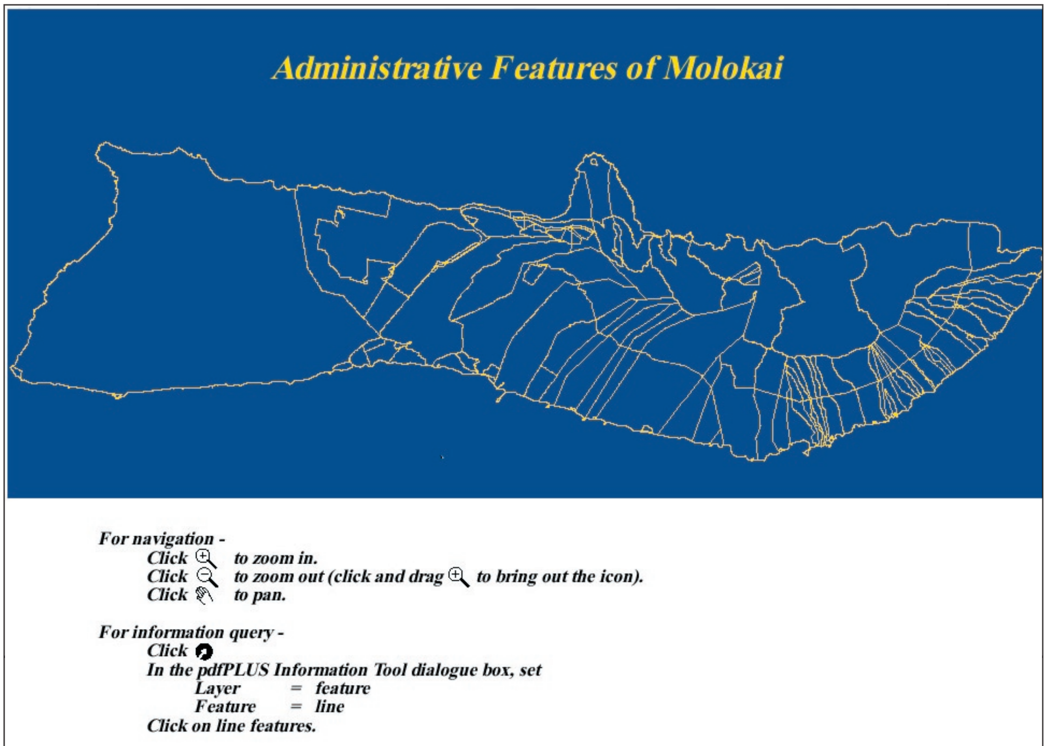
Feature 5

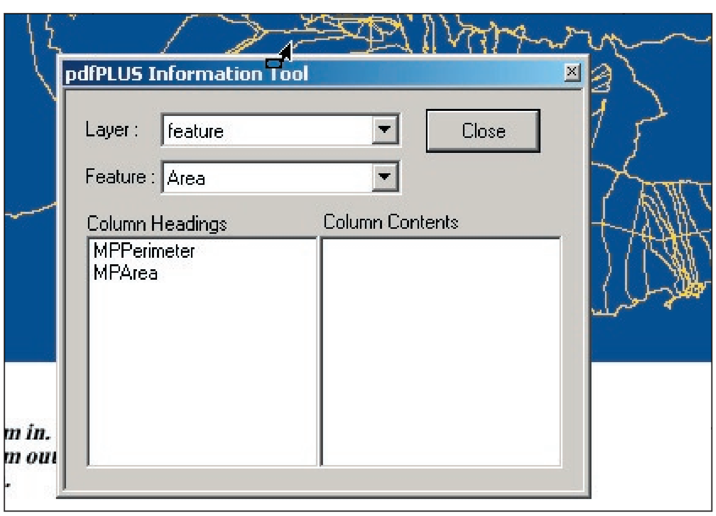
Boundary between Kaluakoi and Palaau ahupua`as. The line was first mapped in 1886 from Monsarrat's survey. Currently the line is the boundary of Moloka`i Ranch and is fenced and quite visable due to the difference in land use on each side of the boundary.

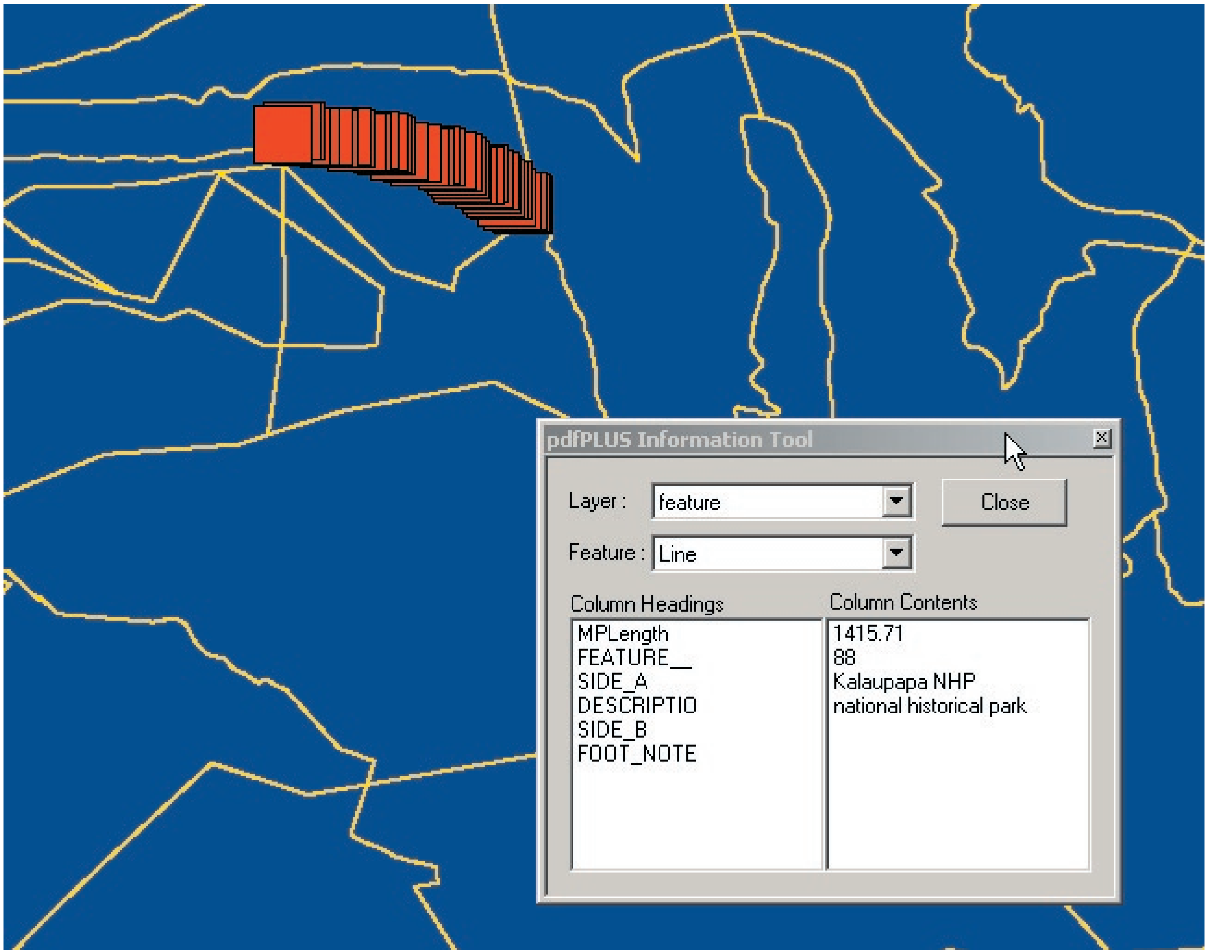
PDF Data Selector Map

PDF: Selecting the PDF form of the Map from the welcoming page begins a quite different sequence of access. This opens a map of Moloka`i with all of the features displayed. To use this form of the data access, a special plugin, the ***pdfPLUS*** by Macromedia, must be loaded and installed. When *pdfPLUS* is installed a special feature set is displayed along the top of the map. A panel is inserted below the map to explain this special Adobe Acrobat Feature set.

Normally, the user will zoom into the area of interest and then select the feature of interest after selecting the ***information arrow*** tool from the pdfPLUS toolbar. This will open the Information Tool window that defaults to “Area” in the Feature window. After changing this to “Line”, the selected line is highlighted and some of the items in the general data base are displayed. As many items from the data base may be included as necessary. However, for this test only part of the data collected were made accessable through this tool.


Administrative Features of Molokai
For navigation -
Click to zoom in.
Click to zoom out (click and drag to bring out the icon).
Click to pan.
For information query -
Click
In the pdfPLUS Information Tool dialogue box, set
Layer = feature
Feature = line
Click on line features.


pdfPLUS Information Tool
Layer : feature
Close
Feature : Area
Column Headings
Column Contents
MPPerimeter
MPArea



A CD is included with this report that includes all of the necessary files to run this demonstration and access the abbreviated form of the data set.

Conclusions and Recommendations

METADATA

Metadata, Theory and Practice

The general introduction of the concept and practice of publishing metadata for all maps spatial data sets has seen a very rocky implementation road, even with the best of intentions. In the beginning, metadata was to apply to all spatial data generated by the Federal Government or developed with federal funds. By their example, it was hoped that the all data agencies in other public and private sectors would follow suit. However, the main proponents of the metadata standard were from sectors who were not fully cognizant of the complexity of much of the spatial data that they wanted described and cataloged.

When the standard was being introduced, trainers insisted that it was to be applied to all spatial data. However, they could not explain how a topographic map could be entered in the existing standard. It was not long before it was acknowledged that the metadata standard was going to be applied mainly to a single layer in a digital data set. When dealing with compiled information, the metadata preparer had to prepare metadata or have access to a detailed description of the sources and methods used in the compilation. Only in situations where information is developed with procedures or methods of known accuracy, can there be a general knowledge of data accuracy, which was one of the main purposes of metadata.

Metadata and Compiled Maps

One of the main principles of metadata is to describe data completely enough to prevent duplication of data development efforts, and to allow users to evaluate whether a data set could meet their needs without redeveloping data. Another goal of metadata is to disseminate data specifications, cost, and stewards to encourage sharing of information. As automated methods of metadata creation were introduced more and more information was available about the digital processing steps involved in transformation of data from collection to where it ended up used in the data base. However, as these data became larger parts of metadata, the accuracy of layers becomes less useful. Yet even with a changing characteristic of the pivotal information, its adoption has not been rapid.

There are a number of issues that made enthusiastic adoption of FGDC compliant metadata slow. Probably the first is the time involved in preparation of a very complete document. Even with the range of metadata development utilities available, it is very tedius to find all the required information. The text format of the metadata was designed for uniform access to the information by anyone with the most basic of computers, however, the format is very verbose and most of the information in a file is formatting information rather than metadata.

However, the largest issue is the data characteristics layer. If a data layer was prepared by digitizing a paper map, it is most likely that the metadata compiler simply does not know the basics about the accuracy of the data or its methods of compilation. As this study has shown it is a very long and detailed process to tease information about a data layer out of public and private records. A procedure that few, if any, metadata compilers would care to assume.

Metadata Boilerplate

However, the required information about Data Quality is avoided in different ways when the compilers are unsure about the sources of the data. It is not easy to find specific metadata reports about information derived from topographic map Digital Line Graphs. Two full-format samples of published FGDC Compliant metadata files are included in Appendices of this report, but it is useful to extract elements from them for this section of the chapter.

The boundaries metadata for the "1:25,000-SCALE DIGITAL LINE GRAPHS; ANCHORAGE A-8 NE,AK" and "1:24,000 DIGITAL LINE GRAPH, PENNS GROVE QUADRANGLE" deal with the source question by quoting the USGS guidelines for digital map standards and the National Map Accuracy Standards as illustrated in the extracts below.

Data_Quality_Information:

Attribute_Accuracy:

Attribute_Accuracy_Report:

The attribute accuracy is estimated to be 98.5 percent. Attribute accuracy was tested by one or more of the following methods: - manual comparison of the source with hard copy plots. - symbolized display of the digital line graph on an interactive computer graphic system. - Selected attributes that could not be visually verified on plots or on screen, were interactively queried and verified on screen. In addition, U.S. Geological Survey (USGS) Production System (PROSYS) software tested the attributes against a master set of valid attributes for the category; it also checked for selected valid attribute combinations, and for valid attributes relative to topology and dimensionality. All attribute data conform to the attribute codes current as of the date of digitizing.

Method Accuracy instead of Data Accuracy

Logical_Consistency_Report:

Topological requirements include: lines must begin and end at nodes, lines must connect to each other at nodes, lines do not extend through nodes, left and right areas are defined for each line element and are consistent throughout the file, and the lines representing the limits of the file (neatline) are free of gaps. The tests of logical consistency were performed by the USGS PROSYS program. The neatline was generated by connecting the four corners of the digital file, as established during initialization of the digital file. All data outside the enclosed region were ignored and all data crossing these geographically straight lines were clipped at the neatline. Data within a specified tolerance of the neatline were snapped to the neatline. Neatline straightening aligned the digitized edges of the digital data with the generated neatline, that is, with the longitude/latitude lines in geographic coordinates. All internal areas were tested for closure using PROSYS.

Completeness_Report:

For Digital Revision Status = Not revised Data completeness re ects the content of the source quadrangle. Features may have been eliminated or generalized on the source graphic, due to scale and legibility constraints. For Digital Revision Status = Limited Update This file has undergone limited update digital revision. The file contains only (1) those features that are photoidentifiable on monoscopic source, supplemented with limited ancillary source, and (2) those features, present on the original source quadrangle, that can not be reliably photoidentified but that are not considered particularly prone to change. For Digital Revision Status = Standard Update This file has undergone standard update digital revision. The data completeness of this file meets NMD standards for feature content.

Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

For Digital Revision Status = Not revised: Horizontal positional accuracy is based upon the use of USGS source quadrangles which are compiled to meet National Map Accuracy Standards (NMAS). NMAS horizontal accuracy requires that at least 90 percent of points tested are within 0.02 inches of the true position. The digital data are estimated to contain a horizontal positional error of less than or equal to 0.003 inches standard error in the two component directions relative to the source quadrangle. Comparison to the graphic source is used as control to assess digital positional accuracy. Cartographic offsets may be present on the graphic source, due to scale and legibility constraints.

Proposed NMAS Accuracy instead of Real Accuracy

Digital map elements require edge alignment between data sets. Data along each quadrangle edge are tested against the data set for the adjacent quadrangle using PROSYS; tests check for positional accuracy between data sets within a 0.02 inches tolerance. Features with like dimensionality, and with or without like attribution, that are within the tolerance are adjusted by moving the feature equally in both data sets. Features outside the tolerance are not moved. All disconnects are identified by edge matching ags that document the mismatch. For Digital Revision Status = Limited Update: This file has undergone limited update digital revision. Accuracy of these digital data meets the class 1 positional accuracy specifications in the draft United States National Cartographic Standards for Spatial Accuracy. Digital map elements require edge alignment between data sets. Data along each quadrangle edge are tested against the data set for the adjacent quadrangle using PROSYS; tests check for positional accuracy between data sets within a 0.02 inches tolerance. Features with like dimensionality, and with or without like attribution, that are within the tolerance are adjusted by moving the feature equally in both data sets. Features outside the tolerance are not moved. All disconnects are identified by edge matching ags that document the mismatch. For Digital Revision Status = Standard Update: This file has undergone standard update digital revision. Accuracy of these digital data meets at least the class 2 positional accuracy specification in the draft United States National Cartographic Standards for Spatial Accuracy. Digital map elements require edge alignment between data sets. Data along each quadrangle edge are tested against the data set for the adjacent quadrangle using PROSYS; tests check for positional accuracy between data sets within a 0.02 inches tolerance. Features with like dimensionality, and with or without like attribution, that are within the tolerance are adjusted by moving the feature equally in both data sets. Features outside the tolerance are not moved. All disconnects are identified by edge matching ags that document the mismatch.

Vertical_Positional_Accuracy:

Vertical_Positional_Accuracy_Report:

For Hypsography, Hydrography and Survey Control and Markers Only: For Digital Revision Status = Not revised: Vertical positional accuracy is based upon the use of USGS source quadrangles which are compiled to meet NMAS.

NMAS vertical accuracy requires that at least 90 percent of well defined points tested be within one half contour interval of the correct value. Comparison to the graphic source is used as control to assess digital positional accuracy. For Hypsography, Hydrography and Survey Control and Markers Only: For Digital Revision Status = Limited Update or Standard Update: This file has undergone digital revision. Accuracy of these digital data meets the class 1 positional accuracy specifications in the draft United States National Cartographic Standards for Spatial Accuracy.

In a later section, under the heading "Process Step", the compiler offers more general boilerplate on scan vectorizing to cover the process of taking the paper data into a data layer form.

Process_Step:

Process_Description:

For Digital Revision Status = Not digitally revised: This Digital Line Graph was digitized from the USGS source quadrangle, by either the National Mapping Division, one of their cooperators, or one of their contractors. The digital data were produced by one of the following methods: - scanning a stable-based copy of the graphic materials. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and then attributed on an interactive editing station. o scanning the paper map. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and then attributed on an interactive editing station. - scanning a stable-based copy of the graphic materials. The resulting raster data were then manually digitized and attributed on an interactive editing station. The resolution of the digital data is at least 0.001 inches. o scanning the paper map. The resulting raster data were then manually digitized and attributed on an interactive editing station. The resolution of the digital data is at least 0.001 inches. - manually digitizing from a stable-based copy of the graphic material using a digitizing table to capture the digital data at a resolution of at least 0.001 inches; attribution was performed either as the data were digitized, or on an interactive edit station after the digitizing was completed. - manually digitizing from the paper map using a digitizing table to capture the digital data at a resolution of at least 0.001 inches; attribution was performed either as the data were digitized, or on an interactive edit station after the digitizing was completed. The determination of the DLG production method was based on various criteria, including feature density, feature symbology, and availability of production systems. Four control points corresponding to the four corners of the quadrangle were used for registration during data collection. An eight parameter projective transformation was performed on the coordinates used in the data collection and editing systems to register the digital data to the internal coordinates used in PROSYS, and a four parameter linear transformation was performed from the PROSYS internal coordinates to Universal Transverse Mercator (UTM) grid coordinates. The DLG data were checked for position by one or more of the following processes: - comparing plots of the digital data to the graphic source. - comparing the digital data to the digital raster scan. DLG data classification was checked by at least one of the following processes. - comparing plots of the digital data to the graphic source - comparing the digital data to the digital raster scan.

And just in case, the user might want more information about the Digital Line Graph standards and production process, the compiler includes over two pages of web sources on DLGs.

Covering all the Bases

U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 3: Attribute Codes: Reston, VA, 1994 Softcopy in Hypertext format is available at: <URL:http://mcmcweb.cr.usgs.gov/~rkelly?part3_stds/>

(1) Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_c.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/

DLG/dlgstnds/gp.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/gp_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/gp_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/hp.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/hy.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/hy_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/ms.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/nv.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/pl.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/pl_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/pl_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/pl_c.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/pl_d.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/
DLG/dlgstnds/rd.txt><URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/
dlgstnds/rr.txt>

However, (yet after 18 pages of boilerplate) there is not one mention of specific accuracy of the information in the layer in other than what the USGS says it should be if all the processing standards are met.

The metadata report for "1:24,000 DLG BOUNDARY DATA - SAN FRANCISCO BAY/ELKHORN SLOUGH" presents a more general approach to the process in its 13 page report. To save on duplication, the compilers summarize the names of the layers for which the data are available.

Abstract:

This category of data consists of (1) political boundaries that identify States, counties, cities, and other municipalities, and (2) administrative boundaries that identify areas such as National and State forests. This data is available for the following quadrangles: ALTAMONT, ANO NUEVO *, ANTIOCH NORTH, ANTIOCH SOUTH, AVENA, BIG BASIN, BRENTWOOD, BRIONES VALLEY, BRUSH LAKE, BYRON HOT SPRINGS, CALAVERAS RESERVOIR, CASTLE ROCK RIDGE, CEDAR MOUNTAIN, CHITTENDEN, CHUALAR, CLAYTON, CLIFTON COURT FOREBAY, COPPER MOUNTAIN, CREVISON PEAK, CROWS LANDING, CUPERTINO, DAVENPORT, DENVERTON, DIABLO, DUBLIN, EYLAR MOUNTAIN, FELTON, FRANKLIN POINT, GILROY, GILROY HOT SPRINGS, GONZALES, HALF MOON BAY, HAYWARD,

HOLLISTER, HOLT, HONKER BAY, HUNTERS POINT, ISABEL VALLEY, LA COSTA VALLEY, LA HONDA, LAS TRAMPAS RIDGE, LATHROP, LAUREL, LICK OBSERVATORY, LIVERMORE, LODI SOUTH, LOMA PRIETA, LONE TREE CREEK, LOS GATOS, MANTECA, MARE ISLAND, MARINA, MARIPOSA PEAK, MIDWAY, MILPITAS, MINDEGO HILL, MISSISSIPPI CREEK, MONTARA MOUNTAIN, MONTARA MOUNTAIN OE W, MONTEREY OE N, MORGAN HILL, MOSS LANDING, MOUNT BOARDMAN, MOUNT DAY, MOUNT HARLAN, MOUNT JOHNSON, MOUNT MADONNA, MOUNT STAKES, MOUNTAIN VIEW, MUSTANG PEAK, NATIVIDAD, NEWARK, NEWMAN, NILES, OAKLAND EAST, OAKLAND WEST, ORESTIMBA PEAK, PACHECO PASS, PACHECO PEAK, PAICINES, PALO ALTO, PATTERSON, PETERS, PIGEON POINT, POINT BONITA, PRUNEDALE, REDWOOD POINT, RICHMOND, RIO VISTA, RIPON, SALIDA, SALINAS, SAN FRANCISCO NORTH, SAN FRANCISCO SOUTH, SAN FRANCISCO SOUTH OE W, SAN GREGORIO, SAN JOSE EAST, SAN JOSE WEST, SAN JUAN BAUTISTA, SAN LEANDRO, SAN MATEO, SAN QUENTIN, SANTA CRUZ, SANTA TERESA HILLS, SOLYO, SOQUEL, STOCKTON EAST, STOCKTON WEST, TASSAJARA, TERMINOUS, TRACY, UNION ISLAND, VALLEY SPRINGS SW, VERNALIS, WALNUT CREEK, WATSONVILLE EAST, WATSONVILLE WEST, WESTLEY, WILCOX RIDGE, WOODSIDE, WOODWARD ISLAND,

Also to save space the compiler just refers us to the documents relevant to Data Quality Information.

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).
Logical_Consistency_Report:
Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE

MAPS: Data User Guide 1).

Completeness_Report:

Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).

Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).

Vertical_Positional_Accuracy:

Vertical_Positional_Accuracy_Report:

Bibliographic Style Citations

Metadata was conceived and designed to provide users with critical information about the characteristics and quality of data that would guide them in the data's application and in decisions about its acceptability, or whether it was necessary to build new data sets. Unfortunately, these worthy goals have not been met. Metadata compilers have instead adherred to the letter of the law rather than delved into the meaning of the data because most compilers simply do not know or cannot find the heritage of the data that they are describing.

The Spirit and Letter of Metadata Practice

FGDC COMPLIANT METADATA FOR MOLOKA`I

A sample Metadata statement for one of the eleven boundary DLGs for Moloka`i has been prepared and is included in Appendix C. In preparing this document according to FGDC guidelines, there was little opportunity to develop detailed information about the lineage of the individual lines and boundaries in the data set, except to list ranges of data quality or characteristics in the various reports. However, an attempt was made to address the specific characteristics of the Moloka`i data.

Trying to fit Heritage into FGDC Metadata

FEATURE LEVEL METADATA

The purpose of this project was to determine the time involved with the development of data heritage for each line or line set in the boundary DLGs for Moloka`i. Even though the staff spent parts of three years formatting and developing information about each boundary on the topographic map representation of Molokai, the work is far from complete. In almost every line there is so much history and deviation, that a definitive statement about the accuracy of even a segment of a line is subject to many compilation constraints. The only way possible to determine the accuracy of each boundary line on Molokai is to resurvey them with the most modern methods available. As it stands, by comparing the representation of the checked lines with the metes and bounds, many of the lines on Molokai would be found reasonably accurate, and others would be very lacking.

Determining Line Accuracy

Feature level metadata is very difficult and time-consuming to develop after the fact. If the compilation contractors used in the 1983 edition of the map were charged with this process, it could be done to a level that would greatly increase the usefulness of the metadata without developing the full heritage of each line. The boundary plots and field completion reports kept by the US Geological Survey, at least for the 1983 series could be easily extended into a partial feature level metadata with very little extra expense or effort since the compilers are quite knowledgeable about the general quality of the linework they have compiled.

A Complete Feature Level Metadata

The quality of feature level metadata on Molokai could be increased in a number of ways that were beyond the scope of this project. If a full relational database were prepared for each line and boundary, the feature level metadata system could become an invaluable administrative and historical tool, especially in Hawai`I where the ahupua`a is so rich with cultural history and a modern framework of land tenure. Scholars, teachers, and interested citizens would find a feature level heritage tool very useful for all manner of applications.

An Example

Molokai Ranch was formed out of ahupua`a land and the modern boundary was originally an ahupua`a boundary. As a local researcher, I would like to have a data base that would let me determine when the boundary was first described by what Alii member and what happened to it in terms of political adjustments before it was surveyed by Pease and then resurveyed by Monsarrat. Looking at the Molokai Ranch boundary today, it does not appear to follow the traditional boundary represented on the topographic maps. What caused that discrepancy? When was the modern survey completed and by whom? The Ranch boundary is a very visible boundary on the landscape due to fencing and different land use practices of each side of the boundary.

Developing feature level metadata to this height involves both a full title search and research involving the cultural history of the Hawaiian Kingdom. In other places, the boundary heritage data may be more accessible, but, the accuracy figure will remain elusive in much of the United States. If feature-level metadata is redefined to preserve the heritage of lines, it can be compiled relatively easily in most areas by discussions with local surveyors and planners who are familiar with the areas. However, if metadata is to describe boundary line accuracy, that is a completely different issue. To develop a set of boundary line accuracies that were field surveyed and then graphically compiled to a scale of 1:24,000 or 1:25,000 is a major task that would involve searches in land records, test plots, drafting of surveyor descriptions, and in some cases, resurvey. Boundary line accuracy is a very difficult subject, in many places not warranting the costs for simple metadata. For that reason, I think it is important to maintain a difference between heritage of a line and accuracy of a line.

Heritage is useful for historical reasons and for educational purposes and should be collected wherever possible, in the same spirit of the many state and federal writers' projects after the 1929 depression. However, boundaries are usually described and recorded to the accuracy needed for their function. We know in Hawai`i, that there is a great deal of variation in boundary accuracy and expect the same for other states and regions. To take the time and money to resurvey lines for the express purpose of determining their mapped accuracy seems to be a very costly exercise, not matter how academically interesting that might be. If a boundary needs to be re-evaluated or resurveyed, the market and legal system will see that it is done. It's important to remember that topographic maps are not legal documents. All maps are subject to liability, but within the guidelines of the designed use.

Feature Level Metadata and Research Time

To compile the boundary line heritage of a single average topographic map would be a function of the density of the linework on the map. In some rural lesser developed areas, the heritage of lines contained on a topographic map could be done in less than a day. In other complex areas with long settlement histories, the process could take many weeks to do properly. To compile boundary heritage metadata for all the maps in the United States would be a daunting task that could solve the unemployment problem. Not unlike the purpose and value of the Public Works Administration Writers Project. The historical documents produced by that Project in the early part of the previous century are still sought out today for the contributions to local history.

As an academic, and as a local citizen, I would like to see boundary line heritage metadata available for all of the DLGs and topographic maps in the country. Whether this is possible, desirable, or economically feasible in the distant future is another question.

FUTURE OF METADATA:

As useful as these first few year's experiment in metadata have been, I would expect that there will be a considerable redefinition of the data structure in the next few years. Users have different needs of metadata and the data that it describes. Data that are highly processed from multiple sources will have to be described by a different method than an aerial photograph that can be perfectly described in a few sentences. The original purpose of metadata was to decrease the duplication of data, but in reality, I doubt that metadata has had much impact on duplication of effort. If two users need nearly but not exactly the same data, it is unlikely that the rather coarse description of metadata will preclude the generation of the second data set in order to exactly meet the needs of the user.

The Redefinition of Metadata

Many agencies have already adopted a "brief" or "condensed" form of metadata that is considerably easier to prepare and edit, but this form is usually done to meet some agency requirements rather than to increase the usefulness of the product. The current form of metadata does well in providing access and format information about data, but falls far short of dealing with compiled data's accuracy and characteristics. A degree of feature level metadata could remedy this, however the format of such additional information is hard to plan. Presenting feature level metadata in tabular form would be unmanageable. An on-line form with graphic and numerical search capability would be a possibility, however, it would make no sense to have feature level metadata in one format and source metadata in another.

Condensed or Brief Form Metadata

If any additional information is to be applied to metadata as we now know it, it would require a complete redefinition of the concept.

GENERAL MOLOKA`I ADMINISTRATION DLG LAYER QUALITY

The use of Moloka`i DLGs as a test of the boundary / administration layer's potential as a "framework" was not the best choice of Hawaiian areas for this test. The large proportion of ahupua`a's in the Molokai data set cause a disproportionate number of inaccurate boundaries. Ahupua`a are largely unsurveyed, relying on metes and bounds descriptions developed by mid 1800s surveyors from traditional knowledge. The data presented on the current USGS maps were interpreted from 1895 Monsarrat 1:25,000 maps and Monsarrat's metes and bounds descriptions.

Ahupua`a and Other Boundary Data

Ahupua`a are represented on all of Hawaii Island maps but their proportion on Molokai are in general greater than other urbanized islands. This proportion of traditional boundaries makes the average accuracy of boundary lower than it might be in other areas. Without replotting all of the metes and bounds data and reinterpretation the tradional meaning of the boundaries, it is difficult to arrive at an average metric for ahupua`a accuracy. There are boundaries that are placed 100s of meters away from their description locations.

The Ahupua`a and Modern Boundaries

In many places where the traditional boundaries follow well defined topographic features, the map representation of the boundaries are quite good. In other areas where the boundaries were developed by political negotiation among the ali`i, the boundaries were subject to change after the Mahele. Unless all of these political decisions were taken into account, and they are not all well documented, the boundaries have a potential of being represented inaccurately.

Since these boundaries are modern adaptions of traditional descriptions affected by political decisions, there is no survey standard to judge their accuracy. However, there are a number of modern land administration and ownership situations that follow the traditional boundaries that can be used as a basis of comparison, but it is a huge exercise in title searching and surveying to finally evaluate their accuracy. Tasks like that are well beyond the scope of this project.

State Forest Reserve Boundaries

Forest Reserve boundaries are variable, as a function of time, date, and definition. The Forest Reserve system began on Moloka`i in 1912 and was a combination of state land and private land that was put under reserve status for a specific lease period. When the time period expired, the private owners could extend the lease or remove their parcels from reserve status. This fluid situation means that a Reserve boundary could move or be redefined on every edition of the map. This has been the situation in the last three editions of the map and it is likely to continue. In some areas, the Forest Reserve boundary is comprised of segments of land parcels that have lines that have been surveyed and in other areas, have lines that have not been surveyed. Therefore, for the static parts of the boundary, there are also variable accuracy representations, however, this project did not attempt to determine the status of the different parts of the line.

Federal Boundaries on Moloka`i

There are very few federal boundaries on Moloka`i. The major boundary is the Kalaupapa National Historical Park boundary that extends along the cliffs above the Kalaupapa Peninsula. Incorporated into this Park Service land was the land occupied by the lighthouse. However, this land was transferred to the Park Service is and no longer a separate unit. The Kalaupapa boundary is not coincident with other boundaries at the top of the cliffs. The boundary overlaps other boundaries to provide a "scenic" easement or setback so that no building or development can be done that can be seen from the Peninsula below. This part of the boundary was determined by the contours of the cliff and was not surveyed. Both this method of determination and fact that it overlaps with other land ownership makes this boundary unfit for framework consideration.

There are some military parcel boundaries. There is an abandoned base on one side of the airport, other Naval Reservations in the area, and some Coast Guard land with Navy land embedded within the Coast Guard Reservations. Most of the rest of the boundaries on Moloka`i are small parks, wildlife refuges, state reservations and Hawaiian Homelands. However, with the exception of Hawaiian Homelands, which cover a large amount of Moloka`i, the other boundaries are very small in extent. The federal boundaries with exception of the Kauaupapa NHP are surveyed boundaries but small enough in extent that they would not likely be used as a framework for general GIS applications.

FRAMEWORK RECOMMENDATIONS

Final Recommendations

Given the variability of accuracy and source types of Molokai boundary data, this study must recommend that it not be used in any way as a framework for other information unless it is cultural in nature. Given our investigations into the heritage of these data, we doubt that there is a class of information on Hawaii DLGs and topographic maps in general that is less accurate or consistent than the boundary information layer.

POSTSCRIPT

FGDC Metadata and Feature Level Metadata

The treasure hunt for scattered heritage information on geographic lines was a fascinating one on Molokai. It lead us in unexpected directions and gave us a greater respect for the Hawaii surveyors of the late 19th century. We were impressed with the local compilers of the 1983 boundary information. There were places where the US Geological Survey did not take their advice and we wish that they had had the opportunity to provide more detail about their sources.

We do not think that FGDC compliant metadata as it is current formulated can be made to easily accommodate feature-level information. However, more detail about map accuracy is very important and should be made a high priority. Information about detailed map accuracy is very hard to determine without tremendous effort and time. Line heritage is easier to determine and almost as valuable, albeit to a somewhat different audience.

In the digital line graph and raster graphic forms of maps that are becoming quite common, it would be a small task to add a "clickable" graphic link to a data base that would tell the user at least the minimum of heritage and accuracy information for a variety of classes. This type of access could also contain a minimal metadata.

It would be quite shortsighted to assume that digital information is just a different form of the same information that is printed on paper maps. To conceive of a digital map as just a different functional type of a paper map, little is gained by the tremendous conversion cost. It is very difficult to express the accuracy and heritage of each symbol on a map because of graphic limitations. However with the attributes that are easily linked to a digital data base, these limitations are removed and a much greater level of map richness could be achieved while making a significant contribution the map as a decision-making tool.

Appendix A

Alaska FGDC Metadata

1:25,000-scale Digital Line Graphs; ANCHORAGE A-8 NE, AK Metadata:

Identification_Information:

Citation:

Citation_Information:

Originator:
U.S. Geological Survey or another mapping agency in cooperation with USGS.
Publication_Date:
Title:
1:25,000-scale Digital Line Graphs; ANCHORAGE A-8 NE, AK BOUNDARIES
Publication_Information:

Publication_Place: Reston, Virginia
Publisher: U.S. Geological Survey
Online_Linkage: `<URL:ftp://agdcftp1.wr.usgs.gov/pub/usgs/dlg/25K/bd/A/anca8nebd.gz>`
Description:

Abstract:
Digital line graph (DLG) data are digital representations of cartographic information. DLG's of map features are converted to digital form from maps and related sources. Large-scale DLG data are derived from USGS 1: 20,000-, 1: 24,000-, and 1: 25,000-scale 7.5-minute topographic quadrangle maps. Large-scale DLG data are available in nine categories: (1) hypsography, (2) hydrography, (3) vegetative surface cover, (4) non-vegetative features, (5) boundaries, (6) survey control and markers, (7) transportation, (8) manmade features, (9) Public Land Survey System. All DLG data distributed by the USGS are DLG - Level 3 (DLG-3), which means the data contain a full range of attribute codes, have full topological

structuring, and have passed certain quality-control checks.

Purpose:

DLG's depict information about geographic features on or near the surface of the Earth, terrain, and political and administrative units. These data were collected as part of the National Mapping Program.

Time_Period_of_Content:

Time_Period_Information:

Multiple_Dates/Time: 1979

Currentness_Reference: see Time Period of Content

Status:

Progress: In work

Maintenance_and_Update_Frequency: Irregular

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: -149.812500
East_Bounding_Coordinate: -149.625000
North_Bounding_Coordinate: 61.250000
South_Bounding_Coordinate: 61.125000

Keywords:

Theme:

Theme_Keyword_Thesaurus: None.
Theme_Keyword: digital line graph
Theme_Keyword: DLG
Theme_Keyword: -149.812500

Place:

Place_Keyword_Thesaurus:

U.S. Department of Commerce, 1977, Countries, dependencies, areas of special sovereignty, and their principal administrative divisions (Federal Information Processing Standard 10-3):Washington, D.C., National Institute of Standards and Technology.

Place_Keyword: US
Place_Keyword: CA
Place_Keyword: Alaska
Place_Keyword: ANCHORAGE
Place_Keyword_Thesaurus:

U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia and the outlying areas of The

United States, and associated areas (Federal Information Processing Standard 5-2):Washington ,D. C., National Institute of Standards and Technology.

Place_Keyword: AK

Access_Constraints: None

Use_Constraints:

None. Acknowledgement of the U.S. Geological Survey would be appreciated in products derived from these data.

Data_Quality_Information:

Attribute_Accuracy:

Attribute_Accuracy_Report:

The attribute accuracy is estimated to be 98.5 percent. Attribute accuracy was tested by one or more of the following methods: - manual comparison of the source with hard copy plots. - symbolized display of the digital line graph on an interactive computer graphic system. - Selected attributes that could not be visually verified on plots or on screen, were interactively queried and verified on screen. In addition, U.S. Geological Survey (USGS) Production System (PROSYS) software tested the attributes against a master set of valid attributes for the category; it also checked for selected valid attribute combinations, and for valid attributes relative to topology and dimensionality. All attribute data conform to the attribute codes current as of the date of digitizing.

Logical_Consistency_Report:

Topological requirements include: lines must begin and end at nodes, lines must connect to each other at nodes, lines do not extend through nodes, left and right areas are defined for each line element and are consistent throughout the file, and the lines representing the limits of the file (neatline) are free of gaps. The tests of logical consistency were performed by the USGS PROSYS program. The neatline was generated by connecting the four corners of the digital file, as established during initialization of the digital file. All data outside the enclosed region were ignored and all data crossing these geographically straight lines were clipped at the neatline. Data within a specified tolerance of the neatline were snapped to the neatline. Neatline straightening aligned the digitized edges of the digital data with the generated neatline, that is, with the longitude/latitude lines in geographic coordinates. All internal areas were tested for closure using PROSYS.

Completeness_Report:

For Digital Revision Status = Not revised Data completeness re ects the content of the source quadrangle. Features may have been eliminated or generalized on the source graphic, due to scale and legibility constraints. For Digital Revision Status = Limited Update This file has undergone limited update digital revision. The file contains only (1) those features that are photoidentifiable on monoscopic source, supplemented with limited ancillary source, and (2) those features, present on the original source quadrangle, that can not be reliably photoidentified but that are not considered particularly prone to change. For Digital Revision Status =

Standard Update This file has undergone standard update digital revision. The data completeness of this file meets NMD standards for feature content.

Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

For Digital Revision Status = Not revised: Horizontal positional accuracy is based upon the use of USGS source quadrangles which are compiled to meet National Map Accuracy Standards (NMAS). NMAS horizontal accuracy requires that at least 90 percent of points tested are within 0.02 inches of the true position. The digital data are estimated to contain a horizontal positional error of less than or equal to 0.003 inches standard error in the two component directions relative to the source quadrangle. Comparison to the graphic source is used as control to assess digital positional accuracy. Cartographic offsets may be present on the graphic source, due to scale and legibility constraints. Digital map elements require edge alignment between data sets. Data along each quadrangle edge are tested against the data set for the adjacent quadrangle using PROSYS; tests check for positional accuracy between data sets within a 0.02 inches tolerance. Features with like dimensionality, and with or without like attribution, that are within the tolerance are adjusted by moving the feature equally in both data sets. Features outside the tolerance are not moved. All disconnects are identified by edge matching ags that document the mismatch. For Digital Revision Status = Limited Update: This file has undergone limited update digital revision. Accuracy of these digital data meets the class 1 positional accuracy specifications in the draft United States National Cartographic Standards for Spatial Accuracy. Digital map elements require edge alignment between data sets. Data along each quadrangle edge are tested against the data set for the adjacent quadrangle using PROSYS; tests check for positional accuracy between data sets within a 0.02 inches tolerance. Features with like dimensionality, and with or without like attribution, that are within the tolerance are adjusted by moving the feature equally in both data sets. Features outside the tolerance are not moved. All disconnects are identified by edge matching ags that document the mismatch. For Digital Revision Status = Standard Update: This file has undergone standard update digital revision. Accuracy of these digital data meets at least the class 2 positional accuracy specification in the draft United States National Cartographic Standards for Spatial Accuracy. Digital map elements require edge alignment between data sets. Data along each quadrangle edge are tested against the data set for the adjacent quadrangle using PROSYS; tests check for positional accuracy between data sets within a 0.02 inches tolerance. Features with like dimensionality, and with or without like attribution, that are within the tolerance are adjusted by moving the feature equally in both data sets. Features outside the tolerance are not moved. All disconnects are identified by edge matching ags that document the mismatch.

Vertical_Positional_Accuracy:

Vertical_Positional_Accuracy_Report:
For Hypsography, Hydrography and Survey Control and Markers Only: For Digital Revision Status = Not revised: Vertical positional accuracy is based upon the use of USGS source quadrangles which are compiled to meet NMAS. NMAS vertical accuracy requires that at least 90 percent of well defined points tested be within one half contour interval of the correct value. Comparison to the graphic source is used as control to assess digital positional accuracy. For Hypsography, Hydrography and Survey Control and Markers Only: For Digital Revision Status = Limited Update or Standard Update: This file has undergone digital revision. Accuracy of these digital data meets the class 1 positional accuracy specifications in the draft United States National Cartographic Standards for Spatial Accuracy.

Lineage:

Source_Information:

Source_Citation:

Citation_Information:

Originator:
U.S. Geological Survey or another mapping agency in cooperation with USGS.

Publication_Date:

Title:
The Topographic Map Names Data Base designation for the source quadrangle.

Geospatial_Data_Presentation_Form: map

Publication_Information:

Publication_Place: Reston, Virginia

Publisher: U.S. Geological Survey

Source_Scale_Denominator: 25000

Type_of_Source_Media: stable-base material

Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 0000

Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: MAP1
Source_Contribution: spatial and attribute information
Source_Information:

Source_Citation:

Citation_Information:

Originator:
U.S. Geological Survey or another mapping agency in cooperation with USGS.
Publication_Date: 0000
Title:
The Topographic Map Names Data Base designation for the DOQ
Geospatial_Data_Presentation_Form: remote-sensing image
Publication_Information:

Publication_Place: Reston, Virginia
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 12000
Type_of_Source_Media: magnetic tape
Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 0000
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: DOQ1
Source_Contribution:
Provides locational and attribute information for photoidentifiable features during revision.
Source_Information:

Source_Citation:

Citation_Information:

Originator:
U.S. Geological Survey or another mapping agency in cooperation with USGS.
Publication_Date: 0000
Title:
The Topographic Map Names Data Base designation for

the DOQ
Geospatial_Data_Presentation_Form: remote-sensing image
Publication_Information:

Publication_Place: Reston, Virginia
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 12000
Type_of_Source_Media: magnetic tape
Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 0000
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: DOQ2
Source_Contribution:
Provides locational and attribute information for photoidentifiable features during revision.
Source_Information:

Source_Citation:

Citation_Information:

Originator:
U.S. Geological Survey or another mapping agency in cooperation with USGS.
Publication_Date: 0000
Title:
The Topographic Map Names Data Base designation for the DOQ
Geospatial_Data_Presentation_Form: remote-sensing image
Publication_Information:

Publication_Place: Reston, Virginia
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 12000
Type_of_Source_Media: magnetic tape
Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 0000

Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: DOQ3
Source_Contribution:
Provides locational and attribute information for photoidentifiable features during revision.
Source_Information:

Source_Citation:

Citation_Information:

Originator:
U.S. Geological Survey or another mapping agency in cooperation with USGS.
Publication_Date: 0000
Title:
The Topographic Map Names Data Base designation for the DOQ
Geospatial_Data_Presentation_Form: remote-sensing image
Publication_Information:

Publication_Place: Reston, Virginia
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 12000
Type_of_Source_Media: magnetic tape
Source_Time_Period_of_Content:

Time_Period_Information:

Single_Date/Time:

Calendar_Date: 0000
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: DOQ4
Source_Contribution:
Provides locational and attribute information for photoidentifiable features during revision.
Process_Step:

Process_Description:
For Digital Revision Status = Not digitally revised: This Digital Line Graph was digitized from the USGS source quadrangle, by either the National Mapping Division, one of their cooperators, or one of their contractors. The digital data were produced by one of the following methods: - scanning a stable-based copy of the graphic materials. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and

then attributed on an interactive editing station. o scanning the paper map. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and then attributed on an interactive editing station. - scanning a stable-based copy of the graphic materials. The resulting raster data were then manually digitized and attributed on an interactive editing station. The resolution of the digital data is at least 0.001 inches. o scanning the paper map. The resulting raster data were then manually digitized and attributed on an interactive editing station. The resolution of the digital data is at least 0.001 inches. - manually digitizing from a stable-based copy of the graphic material using a digitizing table to capture the digital data at a resolution of at least 0.001 inches; attribution was performed either as the data were digitized, or on an interactive edit station after the digitizing was completed. - manually digitizing from the paper map using a digitizing table to capture the digital data at a resolution of at least 0.001 inches; attribution was performed either as the data were digitized, or on an interactive edit station after the digitizing was completed. The determination of the DLG production method was based on various criteria, including feature density, feature symbology, and availability of production systems. Four control points corresponding to the four corners of the quadrangle were used for registration during data collection. An eight parameter projective transformation was performed on the coordinates used in the data collection and editing systems to register the digital data to the internal coordinates used in PROSYS, and a four parameter linear transformation was performed from the PROSYS internal coordinates to Universal Transverse Mercator (UTM) grid coordinates. The DLG data were checked for position by one or more of the following processes: - comparing plots of the digital data to the graphic source. - comparing the digital data to the digital raster scan. DLG data classification was checked by at least one of the following processes. - comparing plots of the digital data to the graphic source - comparing the digital data to the digital raster scan.

Source_Used_Citation_Abbreviation: MAP1

Process_Date: 0000

Process_Step:

Process_Description:

For Digital Revision Status = Limited Update This file has undergone limited update digital revision. Limited update revision uses monoscopic imagery and limited ancillary source, with no field verification.

Source_Used_Citation_Abbreviation: DOQ1, DOQ2, DOQ3, DOQ4

Process_Date: 0000

Process_Step:

Process_Description:

For Digital Revision Status = Standard Update This file has undergone standard update digital revision. Standard update revision uses stereoscopic imagery as needed, in addition to monoscopic imagery, with field verification.

Source_Used_Citation_Abbreviation: DOQ1, DOQ2, DOQ3, DOQ4

Process_Date: 0000

Spatial_Data_Organization_Information:

Indirect_Spatial_Reference:

For Public Land Survey System: U.S. Department of the Interior, Bureau of Land Management: U.S. Public Land Survey System For Boundaries: U.S. Department of Commerce, 1977, Countries, dependencies, areas of special sovereignty, and their principal administrative divisions. (Federal Information Processing Standard 10-3): Washington,D.C., National Institute of Standards and Technology. U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia and the outlying areas of The United States, and associated areas (Federal Information Processing Standard 5-2): Washington, D. C., National Institute of Standards and Technology. U.S. Department of Commerce,1990, Counties and equivalent entities of The United States, its possessions, and associated areas (Federal Information Processing Standard 6-4): Washington, D.C. National Institute of Standards and Technology. For Survey Control and Markers: U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia and the outlying areas of The United States, and associated areas (Federal Information Processing Standard 5-2): Washington, D. C., National Institute of Standards and Technology. U.S. Department of Commerce,1990, Counties and equivalent entities of The United States, its possessions, and associated areas (Federal Information Processing Standard 6-4): Washington, D.C. National Institute of Standards and Technology.

Direct_Spatial_Reference_Method: Vector

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: coordinate pair

Coordinate_Representation:

Abscissa_Resolution: 0.61 [0.635 for 1:25,000]

Ordinate_Resolution: 0.61 [0.635 for 1:25,000]

Planar_Distance_Units: meters

Geodetic_Model:

Horizontal_Datum_Name: North American Datum 1927
Ellipsoid_Name: Clark 1866
Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98
Vertical_Coordinate_System_Definition:

Altitude_System_Definition:

Altitude_Datum_Name: National Geodetic Vertical Datum of 1929
Altitude_Resolution: 1
Altitude_Distance_Units: feet or meters
Altitude_Encoding_Method: attribute values
Depth_System_Definition:

Depth_Datum_Name: Mean lower low water
Depth_Resolution: 1
Depth_Distance_Units: meters or feet
Depth_Encoding_Method: attribute values

Entity_and_Attribute_Information:

Overview_Description:

Entity_and_Attribute_Overview:
DLG3 attribute codes are used to describe the physical and cultural characteristics of DLG node, line, and area elements. Attribute codes are used to reduce redundant information, provide enough reference information to support integration with larger data base, and describe the relationships between cartographic elements. Each DLG element has one or more attribute codes composed of a three digit major code and a four-digit minor code. For example, with the 1: 24,000-scale DLG data, the line attribute code 050 0412 has a major code (050), meaning hydrography, with a minor code (0412) meaning stream.

Entity_and_Attribute_Detail_Citation:
U.S. Department of the Interior, U.S. Geological Survey, 1987 Digital Line Graphs from 1:24,000-Scale Maps--Data Users Guide 1; Reston, Virginia Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/24kdlgguide/dugdlg24.txt>Softcopy in WordPerfect format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/24kdlgguide/dugdlg24.wp5>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/24kdlgguide/dugdlg24.ps>
U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 1: General: Reston, VA, 1994 Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/

stpt1all.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt1all.wp5>
Softcopy in PostScript format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt1all.ps>
U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 2: Specifications: Reston, VA, 1994 Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2txt.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2c.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2txt.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2a.wp5>
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Softcopy in PostScript format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2txt.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2a.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2b.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2c.ps>
U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 3: Attribute Codes: Reston, VA, 1994 Softcopy in Hypertext format is available at: <URL:http://mcmcweb.cr.usgs.gov/~rkelly?part3_stds/>
Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_c.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/hp.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/hy.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/hy_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ms.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/nv.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_c.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_d.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rd.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rr.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/

DLG/dlgstnds/sc.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sm.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ti.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_a.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_b.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_c.wp5>
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<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp_b.wp5>
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Softcopy in PostScript format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.ps>
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<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_b.ps>
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<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_a.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_b.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_c.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_d.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rd.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rr.ps>

<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sc.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sm.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ti.ps>

Distribution_Information:

Distributor:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization: Earth Science Information Center, U.S.Geological Survey

Contact_Address:

Address_Type: mailing address
Address: 507 National Center
City: Reston
State_or_Province: Virginia
Postal_Code: 22092

Contact_Voice_Telephone: 1 800 USA MAPS
Hours_of_Service: 0800-1600
Contact_Instructions:
In addition to the address above there are other ESIC offices throughout the country. A full list of these offices is at: <URL:http://www-nmd.usgs.gov/esic/esic_index.html>

Resource_Description: 1:24,000-scale digital line graphs
Distribution_Liability:
Although these data have been processed successfully on a computer system at the U.S. Geological Survey, no warranty expressed or implied is made by the USGS regarding the utility of the data on any other system, nor shall the act of distribution constitute any such warranty. The Geological Survey will warrant the delivery of this product in computer-readable format, and will offer appropriate adjustment of credit when the product is determined unreadable by correctly adjusted computer input peripherals, or when the physical medium is delivered in damaged condition. Requests for adjustment of credit must be made within 90 day from the date of this shipment from the ordering site.
Standard_Order_Process:

Digital_Form:

Digital_Transfer_Information:

Format_Name: SDTS
Format_Version_Date: 199207

Format_Specification: Topological Vector Profile
Digital_Transfer_Option:

Offline_Option:

Offline_Media: 9-track tape
Recording_Capacity:

Recording_Density: 1600
Recording_Density: 6250
Recording_Density_Units: characters per inch
Recording_Format:
ASCII; available unlabelled or with ANSI-standard labels; available block sizes are 2048 and 30720 characters.
Digital_Form:

Digital_Transfer_Information:

Format_Name: DLG
Format_Version_Date: 198805
Format_Specification: Optional
Digital_Transfer_Option:

Offline_Option:

Offline_Media: 9-track tape
Recording_Capacity:

Recording_Density: 1600
Recording_Density: 6250
Recording_Density_Units: characters per inch
Recording_Format:
ASCII; available unlabelled or with ANSI-standard labels; available block sizes are multiples of 80 characters ranging from 8000 to 32720 characters.
Digital_Form:

Digital_Transfer_Information:

Format_Name: DLG
Format_Version_Date: 198805
Format_Specification: Standard
Digital_Transfer_Option:

Offline_Option:

Offline_Media: 9-track tape
Recording_Capacity:

Recording_Density: 1600
Recording_Density: 6250
Recording_Density_Units: characters per inch

Recording_Format:
ASCII; available unlabelled or with ANSI- standard labels; available block sizes are multiples of 144 characters ranging from 8064 to 32720 characters.

Digital_Form:

Digital_Transfer_Information:

Format_Name: DLG
Format_Version_Date: 198805
Format_Specification: Standard
File_Decompression_Technique: gzip
Transfer_Size: ??

Digital_Transfer_Option:

Online_Option:

Computer_Contact_Information:

Network_Address:

Network_Resource_Name:
<URL:ftp://agdcftp1.wr.usgs.gov/pub/usgs/dlg/25K/bd/A/anca8nebd.gz>

Online_Computer_and_Operating_System:
Data General AViiON 6220 system running DG/UX version 5.4R3.10 (UNIX)

Fees:
The online copy of the data set (when available electronically) may be accessed without charge. For 8-mm cartridge and 9-track tapes the costs are: 1 digital product = $40 2 digital products = $60 3 digital products = $80 4 digital products = $100 5 digital products = $120 6 or more = $90 plus $7 per each product over six A $3.50 handling charge is applied to all mail orders.

Ordering_Instructions:
All nonstandard quadrangles with neatlines that extend beyond the standard unit size to accommodate overedge boundaries are collected as multiples of the standard unit size. Data covering a 7.5- by 8.5- minute quadrangle area would be sold as two 7.5-minute units. Each 7.5-minute unit is distributed as 1 7.5-minute cell, except in high-density areas, where the 7.5-minute cells may be divided into 2 or more cells. The transportation category of data includes major transportation systems collected in three separate

overlays labeled: (1) Roads and Trails, (2) Railroads, and (3) Pipelines, Transmission Lines, and Miscellaneous Transportation Features. Although collected separately, the three files are distributed as a single unit. Orders for the transportation category for a given area will include all three files.

Metadata_Reference_Information:

Metadata_Date: 19901
Metadata_Contact:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization: U.S. Geological Survey
Contact_Address:

Address_Type: mailing address
Address: 508 National Center
City: Reston
State_or_Province: Virginia
Postal_Code: 22092
Contact_Voice_Telephone: 1 703 648 4543
Metadata_Standard_Name: Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: 19940608

Generated by `mp` on Tue Sep 30 08:42:41 1997

Appendix B

California FGDC Metadata

1:24000 DLG Boundary Data Available on the San Francisco Bay/ Elkhorn Slough Change Analysis CD-ROM
Metadata:

Identification_Information:
Citation:

Citation_Information:

Originator: Coastal Services Center
Publication_Date: 19980201
Title:
1:24000 DLG Boundary Data Available on the San Francisco Bay/ Elkhorn Slough Change Analysis CD-ROM
Geospatial_Data_Presentation_Form: Map
Publication_Information:

Publication_Place: Charleston, SC
Publisher: NOAA Coastal Services Center
Larger_Work_Citation:

Citation_Information:

Originator: NOAA Coastal Services Center
Publication_Date: 19980201
Title: San Francisco Bay/Elkhorn Slough Change Analysis
Publication_Information:

Publication_Place: Charleston, SC
Publisher: NOAA Coastal Services Center
Other_Citation_Details:
NOAA Coastal Change and Analysis Program (C-CAP) is developing a nationally standardized database of land cover and habitat change in the coastal regions of the United States. C-CAP inventories coastal submersed habitats, wetland habitats, and adjacent uplands through analysis of satellite imagery (primarily landsat thematic mapper), aerial photography, and field data. These are

interpreted, categorized, and integrated with other spatial data in a geographic information system.

Description:

Abstract:

This category of data consists of (1) political boundaries that identify States, counties, cities, and other municipalities, and (2) administrative boundaries that identify areas such as National and State forests. This data is available for the following quadrangles: ALTAMONT, ANO NUEVO *, ANTIOCH NORTH, ANTIOCH SOUTH, AVENA, BIG BASIN, BRENTWOOD, BRIONES VALLEY, BRUSH LAKE, BYRON HOT SPRINGS, CALAVERAS RESERVOIR, CASTLE ROCK RIDGE, CEDAR MOUNTAIN, CHITTENDEN, CHUALAR, CLAYTON, CLIFTON COURT FOREBAY, COPPER MOUNTAIN, CREVISON PEAK, CROWS LANDING, CUPERTINO, DAVENPORT, DENVERTON, DIABLO, DUBLIN, EYLAR MOUNTAIN, FELTON, FRANKLIN POINT, GILROY, GILROY HOT SPRINGS, GONZALES, HALF MOON BAY, HAYWARD, HOLLISTER, HOLT, HONKER BAY, HUNTERS POINT, ISABEL VALLEY, LA COSTA VALLEY, LA HONDA, LAS TRAMPAS RIDGE, LATHROP, LAUREL, LICK OBSERVATORY, LIVERMORE, LODI SOUTH, LOMA PRIETA, LONE TREE CREEK, LOS GATOS, MANTECA, MARE ISLAND, MARINA, MARIPOSA PEAK, MIDWAY, MILPITAS, MINDEGO HILL, MISSISSIPPI CREEK, MONTARA MOUNTAIN, MONTARA MOUNTAIN OE W, MONTEREY OE N, MORGAN HILL, MOSS LANDING, MOUNT BOARDMAN, MOUNT DAY, MOUNT HARLAN, MOUNT JOHNSON, MOUNT MADONNA, MOUNT STAKES, MOUNTAIN VIEW, MUSTANG PEAK, NATIVIDAD, NEWARK, NEWMAN, NILES, OAKLAND EAST, OAKLAND WEST, ORESTIMBA PEAK, PACHECO PASS, PACHECO PEAK, PAICINES, PALO ALTO, PATTERSON, PETERS, PIGEON POINT, POINT BONITA, PRUNEDALE, REDWOOD POINT, RICHMOND, RIO VISTA, RIPON, SALIDA, SALINAS, SAN FRANCISCO NORTH, SAN FRANCISCO SOUTH, SAN FRANCISCO SOUTH OE W, SAN GREGORIO, SAN JOSE EAST, SAN JOSE WEST, SAN JUAN BAUTISTA, SAN LEANDRO, SAN MATEO, SAN QUENTIN, SANTA CRUZ, SANTA TERESA HILLS, SOLYO, SOQUEL, STOCKTON EAST, STOCKTON WEST, TASSAJARA, TERMINOUS, TRACY, UNION ISLAND, VALLEY SPRINGS SW, VERNALIS, WALNUT CREEK, WATSONVILLE EAST, WATSONVILLE WEST, WESTLEY, WILCOX RIDGE, WOODSIDE, WOODWARD ISLAND,

Purpose:

The DLG data files derived from the 1:24,000-scale and other large-scale maps contain selected base categories such as boundaries, hydrography, public land survey system, transportation, other significant manmade structures, hypsography and surface cover.

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: unknown
Ending_Date: unknown
Currentness_Reference: publication date
Status:

Progress: Complete
Maintenance_and_Update_Frequency: unknown
Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: -123.1257
East_Bounding_Coordinate: -120.8681
North_Bounding_Coordinate: 38.2580
South_Bounding_Coordinate: 36.4897
Keywords:

Theme:

Theme_Keyword_Thesaurus: None
Theme_Keyword: DLG Data
Theme_Keyword: Quadrangles
Place:

Place_Keyword_Thesaurus: None
Place_Keyword: United States
Place_Keyword: Pacific Coast
Place_Keyword: Central California
Place_Keyword: San Francisco
Place_Keyword: San Francisco Bay
Access_Constraints: none
Use_Constraints: none
Point_of_Contact:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization: NOAA Coastal Services Center
Contact_Person: Clearinghouse Manager
Contact_Position: Clearinghouse Manager
Contact_Address:

Address_Type: mailing and physical address

Address: 2234 South Hobson Avenue
City: Charleston
State_or_Province: South Carolina
Postal_Code: 29405
Country: USA
Contact_Voice_Telephone: (843) 740-1210
Contact_Facsimile_Telephone: (843) 740-1224
Contact_Electronic_Mail_Address: clearinghouse@csc.noaa.gov
Hours_of_Service: Monday-Friday, 8-5, Eastern Standard Time
Native_Data_Set_Environment:
ArcView version 3.0a p:\data\dlgdata.shp

Data_Quality_Information:
Attribute_Accuracy:

Attribute_Accuracy_Report:
Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).
Logical_Consistency_Report:
Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).
Completeness_Report:
Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).
Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:
Please see enclosed USGS metadata /data/dlgdata/dlg24.txt (DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS: Data User Guide 1).
Vertical_Positional_Accuracy:

Vertical_Positional_Accuracy_Report:
Lineage:

Source_Information:

Source_Citation:

Citation_Information:

Originator: United States Geological Survey
Publication_Date: unknown
Title: 1:24,000 Digital Line Graph Data
Edition: unknown

Geospatial_Data_Presentation_Form: map
Publication_Information:

Publication_Place: Sioux Falls, SD
Publisher: USGS/Earth Resources Observation Systems
Source_Scale_Denominator: 24000
Type_of_Source_Media: internet
Source_Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: unknown
Ending_Date: unknown
Source_Currentness_Reference: unknown
Source_Citation_Abbreviation: USGS
Source_Contribution:
This data was incorporated into the San Francisco Bay Land Cover Change CD-ROM.
Process_Step:

Process_Description:
This dataset was converted from SDTS, the Spatial Data Transfer Standard, to ArcInfo coverages, using the sdtsimport command in Arc. The related tables containing the attributes were then joined to the attribute table as follows: join .pjoin to .pat using attribute cover-id join .abdf to attribute table using attribute modn_id The coverages were then converted to shapefiles. These processes were automated with AML and AVENUE, the scripting languages for ArcInfo and ArcView.
Process_Date: 19980108
Process_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Organization: NOAA Coastal Services Center
Contact_Person: Dorsey Worthy
Contact_Position: Program Manager Coastal Change Analysis Program
Contact_Address:

Address_Type: mailing and physical address
Address: 2234 South Hobson Avenue
City: Charleston
State_or_Province: South Carolina

Postal_Code: 29405
Country: USA
Contact_Voice_Telephone: (843) 740-1210
Contact_Facsimile_Telephone: (843) 740-1224
Contact_Electronic_Mail_Address: csc@csc.noaa.gov
Hours_of_Service: Monday-Friday, 8-5, Eastern Standard Time

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:

SDTS_Terms_Description:

SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
Point_and_Vector_Object_Count:

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:

Planar:

Grid_Coordinate_System:

Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:

UTM_Zone_Number: 10
Transverse_Mercator:

Scale_Factor_at_Central_Meridian: .99960
Longitude_of_Central_Meridian: -75.000
Latitude_of_Projection_Origin: 0.000
False_Easting: 500000.000000
False_Northing: 0.000
Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: Coordinate pair
Coordinate_Representation:

Abscissa_Resolution:
Ordinate_Resolution:
Planar_Distance_Units: Meters
Geodetic_Model:

Horizontal_Datum_Name: North American Datum 1927
Ellipsoid_Name: Clarke 1866

Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98

Entity_and_Attribute_Information:
Detailed_Description:

Entity_Type:

Entity_Type_Label: b3712238.dbf
Entity_Type_Definition: Shapefile Attribute Table
Entity_Type_Definition_Source: None
Attribute:

Attribute_Label: Area
Attribute_Definition: Area of polygon
Attribute_Definition_Source: Software computed
Attribute_Domain_Values:

Range_Domain:

Range_Domain_Minimum: 2428.219
Range_Domain_Maximum: 111849208.000
Attribute:

Attribute_Label: Perimeter
Attribute_Definition: Perimeter of polygon
Attribute_Definition_Source: Software computed
Attribute_Domain_Values:

Range_Domain:

Range_Domain_Minimum: 237.998
Range_Domain_Maximum: 82006.875
Attribute:

Attribute_Label: Bd3712238_
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Range_Domain:

Range_Domain_Minimum: 2
Range_Domain_Maximum: 31
Attribute:

Attribute_Label: Bd3712238_

Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Range_Domain:

Range_Domain_Minimum: 2
Range_Domain_Maximum: 31

Attribute:

Attribute_Label: Modn_id
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Range_Domain:

Range_Domain_Minimum: 2
Range_Domain_Maximum: 31

Attribute:

Attribute_Label: Entity_lab
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: Civil_town
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: City
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: National_f
Attribute_Definition:

Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field
Attribute:

Attribute_Label: Wilderness
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field
Attribute:

Attribute_Label: Ahupuaa
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field
Attribute:

Attribute_Label: Hawaiian_h
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field
Attribute:

Attribute_Label: Federally_
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field
Attribute:

Attribute_Label: In_dispute
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field
Attribute:

Attribute_Label: State

Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: County
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: Township_c
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: Photorevis
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: Monument_n
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Attribute:

Attribute_Label: Best_estim
Attribute_Definition:
Attribute_Definition_Source: User Defined
Attribute_Domain_Values:

Unrepresentable_Domain: Character field

Distribution_Information:

Distributor:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization: NOAA Coastal Services Center
Contact_Person: Clearinghouse Manager
Contact_Position: Clearinghouse Manager
Contact_Address:

Address_Type: mailing and physical address
Address: 2234 South Hobson Avenue
City: Charleston
State_or_Province: South Carolina
Postal_Code: 29405-2413
Country: USA
Contact_Voice_Telephone: (843) 740-1210
Contact_Facsimile_Telephone: (843) 740-1224
Contact_Electronic_Mail_Address: clearinghouse@csc.noaa.gov
Hours_of_Service: Monday-Friday, 8-5, Eastern Standard Time
Resource_Description:
This dataset is part of the San Francisco Bay Land Cover Change product.
Distribution_Liability:
Users must assume responsibility to determine the usability of these data.
Standard_Order_Process:

Digital_Form:

Digital_Transfer_Information:

Format_Name: ArcView Shapefile
Digital_Transfer_Option:

Offline_Option:

Offline_Media: CDROM
Recording_Format: ISO 9660
Compatibility_Information:
ISO 966 format allows the CDROM to be read by most computer operating systems.
Fees:
none

Metadata_Reference_Information:
Metadata_Date: 19980128

Metadata_Review_Date: 19990701
Metadata_Contact:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization: NOAA Coastal Services Center
Contact_Person: Dorsey Worthy
Contact_Position: Program Manager Coastal Change Analysis Program
Contact_Address:

Address_Type: mailing and physical address
Address: 2234 South Hobson Avenue
City: Charleston
State_or_Province: South Carolina
Postal_Code: 29405
Country: USA
Contact_Voice_Telephone: (843) 740-1210
Contact_Facsimile_Telephone: (843) 740-1224
Contact_Electronic_Mail_Address: csc@csc.noaa.gov
Hours_of_Service: Monday-Friday, 8-5, Eastern Standard Time
Metadata_Standard_Name: FGDC CSDGM
Metadata_Standard_Version: FGDC-STD-001-1998
Generated by `mp` version 2.2.4 on Thu May 4 15:01:23 2000

Appendix C

Moloka`i FGDC Metadata

1:25,000-scale Digital Line Graph; Boundaries, Molokai Airport, Hawaii.

Metadata:

Identification_Information:

Citation:

Citation_Information:

Originator: U.S. Geological Survey in cooperation with Hawaii State Agencies and Private compilation contractors.

Publication_Date: 1983

Title: 1:25,000-scale Digital Line Graph; Molokai Airport, Hawaii.

Publication_Information:

Publication_Place: Reston, Virginia

Publisher: U.S. Geological Survey

Online_Linkage:

Description:

Abstract:

Digital line graph (DLG) data are digital representations of cartographic information scan digitized from scale-stable separates made from the 1:25,000-scale 7.5-minute topographic quadrangle map compilations. The Molokai 1:25,000 topographic sheets were published in 1983 as two over-sized quadrangles, West Molokai and East Molokai. When the DLGs were prepared, the island tiles reverted to the 7 ½ minute quadrangle formatting of five DLGs Ilio Point, Molokai Airport, Kaunakakai, Kamalo, and Halawa with six overedge North and South quadrangles. Large-scale DLG data are available in nine categories: (1) boundaries, (2) hydrography, (3) pipelines, (4) railroads, (5) transportation,. All DLG data distributed by the USGS are DLG - Level 3 (DLG-3), which means the data contain a full range of attribute codes, have full topological structuring, and have passed certain quality-control checks.

Purpose:

DLG's depict information about geographic features on or near the surface of the Earth, terrain, and political and administrative units. These data were collected as part of the National Mapping Program.

Time_Period_of_Content:

Time_Period_Information:

Multiple_Dates/Time: 1888-1979

Currentness_Reference: Publication Date
Progress: Complete
Maintenance_and_Update_Frequency: Irregular

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: -157.200000
East_Bounding_Coordinate: -157.075000
North_Bounding_Coordinate: 21.208333
South_Bounding_Coordinate: 21.083333

Keywords:

Theme:

Theme_Keyword_Thesaurus: None.
Theme_Keyword: digital line graph
Theme_Keyword: DLG
Theme_Keyword: Boundaries
Theme_Keyword: Administration
Theme_Keyword: Ahupua`a

Place:

Place_Keyword_Thesaurus: None
Place_Keyword: US
Place_Keyword: HI
Place_Keyword: Hawaii
Place_Keyword: Molokai
Place_Keyword: Molokai Airport
Place_Keyword_Thesaurus: None

Access_Constraints: None
Use_Constraints:

None. Acknowledgment of the U.S. Geological Survey would be appreciated in products derived from these data.

Data_Quality_Information:

Attribute_Accuracy:

Attribute_Accuracy_Report:

All lines in this data set were checked for proper coding. No coding errors were found however, in the opinion of the analysts, the coding appears to have been developed for uses related to polygons that the boundaries define, rather than the boundary lines, which may have functions beyond polygon edges. Therefore many of the boundary lines have not been assigned major and minor codes. Many of the lines were parts of boundaries and when assembled became a functional boundary. On the Molokai Airport quadrangle, only 13 of the 56 lines on the DLG were associated with major and minor codes.

Logical_Consistency_Report:

Topological requirements include: lines must begin and end at nodes, lines must connect to each other at nodes, lines do not extend through nodes, left and right areas are defined for each line element and are consistent throughout the file, and the lines representing the limits of the file (neatline) are free of gaps. The data were entered into ArcView and inspected for consistency, development of polygons, and for over and undershoots of the lines. The data were found to be error free topologically.

Completeness_Report:

Complete

Positional_Accuracy:

Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:

The DLG was derived from digitizing scale stable copies of the windowed 1983 map West Molokai. The accuracy of the original data is based upon the use of USGS source quadrangles which are compiled to meet National Map Accuracy Standards (NMAS). NMAS horizontal accuracy requires that at least 90 percent of points tested are within 0.02 inches of the true position. The digital data are estimated to contain a horizontal positional error of less than or equal to 0.003 inches standard error in the two component directions relative to the source quadrangle. However, NMAS makes a distinction between well-defined lines and indefinite lines. Since there is a combination of surveyed and un-surveyed lines on the map, the data have much more latitude of accuracy than the specifications above. NMAS specifies that indefinite features "have no appreciable error". The DLG lines were plotted and overlaid and no noticeable error was detected relative to the source quadrangle. In a sample of the boundary lines, on each quadrangle on Molokai, the original property descriptions were obtained and the boundaries were replotted and compared to both the source quadrangle and the DLG representation. Most of the plotted line tests were within NMAS however there were some lines that differed by more than 3 millimeters (72 ground meters).

Vertical_Positional_Accuracy:
Vertical_Positional_Accuracy_Report:
The boundary data did not contain vertical information.

Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator:
U.S. Geological Survey contracted with RM Towill Corporation to compile information related to boundaries on Molokai for the source topographic map. RM Towill plotted the boundary data on scale Boundary Overlay stable sheets relative to survey control. The boundary information was compiled from property descriptions, ahupua`a surveys by MD Monsarrat in the 1880s and state agencies. These data were then published as Molokai West, Hawaii 1:25,000

Publication_Date: 1983

Geospatial_Data_Presentation_Form: map

Publication_Information:
Publication_Place: Reston, Virginia
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 25000
Type_of_Source_Media: stable-base material
Source_Time_Period_of_Content:
Time_Period_Information: 1888-1982
Single_Date/Time:
Calendar_Date: 1982

Source_Currentness_Reference: legal boundary descriptions
Source_Citation_Abbreviation:
Source_Contribution: spatial and attribute information.

Process_Step:
Process_Description:
This Digital Line Graph was digitized from the USGS source quadrangle, by either the National Mapping Division, one of their coopera-

tors, or one of their contractors. The digital data were produced by one of the following methods: - scanning a stable-based copy of the graphic materials. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and then attributed on an interactive editing station. o scanning the paper map. The scanning process captured the digital data at a scanning resolution of at least 0.001 inches; the resulting raster data were vectorized and then attributed on an interactive editing station. - scanning a stable-based copy of the graphic materials. The resulting raster data were then manually digitized and attributed on an interactive editing station. The resolution of the digital data is at least 0.001 inches. o scanning the paper map. The resulting raster data were then manually digitized and attributed on an interactive editing station. The resolution of the digital data is at least 0.001 inches. - manually digitizing from a stable-based copy of the graphic material using a digitizing table to capture the digital data at a resolution of at least 0.001 inches; attribution was performed either as the data were digitized, or on an interactive edit station after the digitizing was completed. - manually digitizing from the paper map using a digitizing table to capture the digital data at a resolution of at least 0.001 inches; attribution was performed either as the data were digitized, or on an interactive edit station after the digitizing was completed. The determination of the DLG production method was based on various criteria, including feature density, feature symbology, and availability of production systems. Four control points corresponding to the four corners of the quadrangle were used for registration during data collection. An eight parameter projective transformation was performed on the coordinates used in the data collection and editing systems to register the digital data to the internal coordinates used in PROSYS, and a four parameter linear transformation was performed from the PROSYS internal coordinates to Universal Transverse Mercator (UTM) grid coordinates. The DLG data were checked for position by one or more of the following processes: - comparing plots of the digital data to the graphic source. - comparing the digital data to the digital raster scan. DLG data classification was checked by at least one of the following processes. - comparing plots of the digital data to the graphic source - comparing the digital data to the digital raster scan.

Source_Used_Citation_Abbreviation:

Process_Date:

Spatial_Data_Organization_Information:

Indirect_Spatial_Reference:

For Public Land Survey System: U.S. Department of the Interior, Bureau of Land Management: U.S. Public Land Survey System For Boundaries: U.S. Department of Commerce, 1977, Countries, dependencies, areas of special sovereignty, and their principal administrative divisions. (Federal Information Processing Standard 10-3): Washington,D.C., National Institute of Standards and Technology. U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia and the outlying areas of The United States, and associated areas (Federal Information Processing Standard 5-2): Washington, D. C., National Institute of Standards and Technology. U.S. Department of Commerce,1990, Counties and equivalent entities of The United States, its possessions, and associated areas (Federal Information Processing Standard 6-4): Washington, D.C. National Institute of Standards and Technology. For Survey Control and Markers: U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia and the outlying areas of The United States, and associated areas (Federal Information Processing Standard 5-2): Washington, D. C., National Institute of Standards and Technology. U.S. Department of Commerce,1990, Counties and equivalent entities of The United States, its possessions, and associated areas (Federal Information Processing Standard 6-4): Washington, D.C. National Institute of Standards and Technology.

Direct_Spatial_Reference_Method: Vector

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.61 [0.635 for 1:25,000]
Ordinate_Resolution: 0.61 [0.635 for 1:25,000]
Planar_Distance_Units: meters

Geodetic_Model:
Horizontal_Datum_Name: Old Hawaiian Datum
Ellipsoid_Name: Clark 1866
Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98

Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: National Geodetic Vertical Datum of 1929
Altitude_Resolution: 1
Altitude_Distance_Units: meters
Altitude_Encoding_Method: attribute values

Depth_System_Definition:
Depth_Datum_Name: Mean sea level
Depth_Resolution: 1
Depth_Distance_Units: meters

Depth_Encoding_Method: attribute values

Entity_and_Attribute_Information:

Overview_Description:

Entity_and_Attribute_Overview:

DLG3 attribute codes are used to describe the physical and cultural characteristics of DLG node, line, and area elements. Attribute codes are used to reduce redundant information, provide enough reference information to support integration with larger data base, and describe the relationships between cartographic elements. Each DLG element has one or more attribute codes composed of a three digit major code and a four-digit minor code. For example, with the 1: 24,000-scale DLG data, the line attribute code 050 0412 has a major code (050), meaning hydrography, with a minor code (0412) meaning stream.

Entity_and_Attribute_Detail_Citation:

U.S. Department of the Interior, U.S. Geological Survey, 1987
Digital Line Graphs from 1:24,000-Scale Maps--Data Users Guide
1; Reston, Virginia Softcopy in ASCII format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/24kdlgguide/dugdlg24.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/24kdlgguide/dugdlg24.wp5>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/24kdlgguide/dugdlg24.ps>
U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 1: General: Reston, VA, 1994 Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt1all.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt1all.wp5>
Softcopy in PostScript format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt1all.ps>
U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 2: Specifications: Reston, VA, 1994 Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2txt.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2c.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2txt.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2a.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2b.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2c.wp5>
Softcopy in PostScript format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2txt.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2a.ps>

<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2b.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/stpt2-2c.ps>
U.S.Department of the Interior, U.S.Geological Survey, 1990, Standards for Digital Line Graphs, Part 3: Attribute Codes: Reston, VA, 1994 Softcopy in Hypertext format is available at: <URL:http://mcmcweb.cr.usgs.gov/~rkelly?part3_stds/>
Softcopy in ASCII format is available at: <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_c.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/gp_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/hp.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/hy.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/hy_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ms.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/nv.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_a.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_b.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_c.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_d.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rd.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rr.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sc.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sm.txt> <URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ti.txt>
Softcopy in WordPerfect format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.wp5>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_a.wp5>
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<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ti.wp5>
Softcopy in PostScript format is available at:
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/contents.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd.ps>
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<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/bd_b.ps>
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<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_a.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_b.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_c.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/pl_d.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rd.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/rr.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sc.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/sm.ps>
<URL:ftp://www-nmd.usgs.gov/pub/ti/DLG/dlgstnds/ti.ps>

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Earth Science Information Center, U.S.Geological Survey

Contact_Address:
Address_Type: mailing address
Address: 507 National Center
City: Reston
State_or_Province: Virginia
Postal_Code: 22092

Contact_Voice_Telephone: 1 800 USA MAPS
Hours_of_Service: 0800-1600

Contact_Instructions:
In addition to the address above there are other ESIC offices throughout the country. A full list of these offices is at: <URL:http://www-nmd.usgs.gov/esic/esic_index.html>

Resource_Description: 1:24,000-scale digital line graphs
Distribution_Liability:
Although these data have been processed successfully on a computer system at the U.S. Geological Survey, no warranty expressed or implied is made by the USGS regarding the utility of the data on any other system, nor shall the act of distribution constitute any such warranty. The Geological Survey will warrant the delivery of this product in computer-readable format, and will offer appropriate adjustment of credit when the product is determined unreadable by correctly adjusted computer input peripherals, or when the physical medium is delivered in damaged condition. Requests for adjustment of credit must be made within 90 day from the date of this shipment from the ordering site.

Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: SDTS
Format_Version_Date: 199207
Format_Specification: Topological Vector Profile

Digital_Transfer_Option:
Offline_Option:
Offline_Media: 9-track tape
Recording_Capacity:
Recording_Density: 1600
Recording_Density: 6250
Recording_Density_Units: characters per inch
Recording_Format:
ASCII; available unlabelled or with ANSI-standard labels; available block sizes are 2048 and 30720 characters.
Digital_Form:
Digital_Transfer_Information:
Format_Name: DLG
Format_Version_Date: 198300
Format_Specification: Optional

Digital_Transfer_Option:
Offline_Option:
Offline_Media: 9-track tape
Recording_Capacity:
Recording_Density: 1600
Recording_Density: 6250

Recording_Density_Units: characters per inch
Recording_Format:
ASCII; available unlabelled or with ANSI-standard labels; available block sizes are multiples of 80 characters ranging from 8000 to 32720 characters.

Digital_Form:
Digital_Transfer_Information:
Format_Name: DLG
Format_Version_Date: 198805
Format_Specification: Standard

Digital_Transfer_Option:
Offline_Option:
Offline_Media: 9-track tape
Recording_Capacity:
Recording_Density: 1600
Recording_Density: 6250
Recording_Density_Units: characters per inch
Recording_Format:
ASCII; available unlabelled or with ANSI- standard labels; available block sizes are multiples of 144 characters ranging from 8064 to 32720 characters.

Digital_Form:
Digital_Transfer_Information:
Format_Name: DLG
Format_Version_Date: 198805
Format_Specification: Standard
File_Decompression_Technique: gzip
Transfer_Size: ??

Digital_Transfer_Option:
Online_Option:
Computer_Contact_Information:
Network_Address:
Network_Resource_Name:
<URL:ftp://agdcftp1.wr.usgs.gov/pub/usgs/dlg/25K/bd/A/anca8nebd.gz>
Online_Computer_and_Operating_System:
Data General AViiON 6220 system running DG/UX version 5.4R3.10 (UNIX)

Fees:
The online copy of the data set (when available electronically) may be accessed without charge. For 8-mm cartridge and 9-track tapes the costs are: 1 digital product = $40 2 digital products = $60 3 digital products = $80 4 digital products = $100 5 digital products = $120 6 or more = $90 plus $7 per each product over six A $3.50 handling charge is applied to all mail orders.

Ordering_Instructions:

All nonstandard quadrangles with neatlines that extend beyond the standard unit size to accommodate overedge boundaries are collected as multiples of the standard unit size. Data covering a 7.5- by 8.5- minute quadrangle area would be sold as two 7.5-minute units. Each 7.5-minute unit is distributed as 1 7.5-minute cell, except in high-density areas, where the 7.5-minute cells may be divided into 2 or more cells. The transportation category of data includes major transportation systems collected in three separate overlays labeled: (1) Roads and Trails, (2) Railroads, and (3) Pipelines, Transmission Lines, and Miscellaneous Transportation Features. Although collected separately, the three files are distributed as a single unit. Orders for the transportation category for a given area will include all three files.

Metadata_Reference_Information:
Metadata_Date: 2002
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: Department of Planning and Economic Development and Tourism, Hawaii State Government

Contact_Address:
Address_Type: mailing address
Address: No. 1 Capitol District Building
`250 S. Hotel Street`
City: Honolulu
State_or_Province: Hawaii
Postal_Code: 96813
Contact_Voice_Telephone: (808) 586-2423
Metadata_Standard_Name: Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: 19940608

Appendix D

Kamalo Quadrangle Report

Advance Field Completion - Field Completion

KAMALO QUADRANGLE REPORT

Boundaries

The ahupuaa boundaries on this quadrangle required a disproportioned and inordinate effort in document research, field investigations and in the compilation on the boundary overlay.

Overlay

Triangulation stations and computable boundaries were computer-plotted on this copy of the USGS base sheet.

All boundaries are plotted for final use hereon. They have been plotted from:

a. Computable boundary plats of private and government surveys accepted as reliable.

b. From metes and bounds descriptions primarily prepared by or based on surveys made by M. D. Monsarrat, a contract surveyor for the Territory of Hawaii before and around the turn of the century. These metes and bounds surveys are mostly related to still existing triangulation stations (which he had established) and which were integrated into the USC&GS triangulation net lateron. These metes and bounds surveys were plotted at a suitable scale and reduced photographically to a scale of 1:25000 and matched to the plotted triangulation stations. Some were plotted directly at 1:25000.

   An intensive field search was conducted to find the original boundary monuments. Only little evidence was found. Few fences exist and most serve merely as cattle fences along gulches and are not defining boundaries. Former and current ranch managers and landowners were interviewed, but generally exact boundary locations, or especially boundary monuments are not known since no surveys were made of most ahupuaa boundaries since about 1898.

   Boundary monuments found in the field are identical to triangulation stations measured by USGS or USC&GS. Certain other boundary corners having been USGS or USC&GS control stations were not found but their coordinates were used in plotting the boundaries.

The boundary overlay is the best plot of all boundaries. A legend, as well as qualifying labels and notes, should enable evaluation with respect to the reliability and suitability for publishing.

KAMALO QUADRANGLE REPORT (continued)

For some boundaries, especially in the upper left-hand section of the quad sheet, boundaries are neither directly related to triangulation stations nor could any ground evidence be found. These have been plotted, subject to evaluation by USGS with respect to their suitability for publishing. They are probably within 200 feet of their true position, but this cannot be ascertained. See qualifying labels.

ones!!

Certain boundaries are lacking reliable documentation or field evidence and should not be considered for publication and are omitted therefore. To this category belong also all boundaries described or made by Mr. Pease, a Surveyor General of the 1860 period.

The comments on individual boundary problems are directly labelled on the boundary overlay (plot) and are not repeated here.

Forest Reserve Boundaries

These boundaries were broadly described in a Governor's Proclamation of 1912, followed by certain amendments. An intensive research was conducted at the State offices, particularly at the Forestry Division. However, a definitive current perimeter could not be ascertained due to incomplete or conflicting information. Therefore, where a contiguous fence exists, it was picture-identified. In other areas, only fragments could be found, connecting of which would make for an incorrect boundary definition. It is recommended that the State Forester receive a composite print of the affected quad sheets for review before final publishing. NO

We have on hand all the information that we [illegible] to plot this bdy. Look

Place Names

Vast population shifts have taken place especially in North, Central and East Molokai. Certain areas, Wailau, Pelekumu and Waikolu, are now devoid of any population whatsoever. Consequently, place names are known only by few people, and only in part. Younger persons generally have very little knowledge of place names, even in more populous areas.

Every attempt has been made to confirm the application and spelling of names, and in case of controversies, to find a basis for a definite recommendation.

Roads

Certain trails or Class 4 roads shown on the 1968 quadrangles are not usable anymore due to erosion or overgrowth and are not mapworthy anymore, or have changed to Class 5.

Bench Marks and Triangulation Stations

All bench marks and nearly all horizontal control stations have been visited. See recovery reports. In order to have a better chance of finding bench marks, the location of these benches as shown on the 1923 USGS map were transferred to the 1968 quads before the search was begun.

Signature omitted [redacted]

(SEE NEXT PAGE) Item 11

KAMALO Quadrangle

BOUNDARY REVIEW

The Contractor has delineated all the boundaries on a Boundary Oversheet (BO).

The boundaries shown on the BO supersede the grid locations of all the boundaries that are shown on the old 1968 map.

No "indefinite" labels should be shown on the new map.

AHUPUAA & FOREST RESERVE Boundaries

All these boundaries which are plotted on the BO, have been reviewed and corrected when needed.

Wildlife Refuge - The KAKAHAIA NATIONAL WILDLIFE REFUGE is plotted on the orthophoto.

NAME INFORMATION

I have made some corrections on the north-half portion of the quad. The green labels MOLOKAI DISTRICT and KALAWAO DISTRICT are correct.

The labels Kalawao County and Maui County are not applicable. (ALSO SEE NEXT PAGE)

CORRECTIONS (planimetry & topography)

See BL-2 for two areas that have been re-scribed.

Name removed

[redacted] (May, 1982)

FIELD COMPLETION REPORT

Advance Field Completion (X)
Field Completion ( )
Field Sketching ( )

*IDENTIFICATION

Quadrangle Name Kamalo State Hawaii Project Molokai Mapping

Field Engineers [redacted], [redacted] Project Engineer [redacted]

Date Begun November 17, 1980 Date Completed February 16, 1981

CONTROL: (Horizontal and Supplemental Vertical)

1. Did aerotriangulator question any horizontal control points? No
   a. Note results of investigation N/A

2. Did the compilers question any vertical supplemental control points? (See Item 6) No
   a. Note results of investigation N/A

3. Did the field work indicate that any control points were in error? No

STEREO COMPILATION

1. Was the compilation clearly drawn and reproduced? ________

2. Was the compilation complete within the limits of the information furnished and the photography? ________

3. Was the topographic expression good? ________

4. Do you recommend any recompilation or additional compilation by photogrammetry from new data? (If yes, explain in Item 11) ________

5. Are you furnishing additional control for recompilation? ________

Remarks: ________

*FIELD MATERIALS

Were the materials furnished complete and satisfactory? Yes

ACCURACY

1. In your opinion does the map as compiled and field corrected meet Map Accuracy Standards? Yes

(over)

Item 10

2. This map (does)(does not) comply with National Map Accuracy Standards ________ ____,District Engineer, Project Engineer, or Chief, Field Surveys Inspection Section.
Remarks: ____

*NAME

1. What names do you recommend for the published quadrangle?

1st Choice Kamalo Remarks: ____________

2nd Choice ____________ Remarks: ____________

3rd Choice ____________ Remarks: ____________

*GENERAL

1. Do you think the present contour interval is appropriate? Yes

2. Were there any unusual conditions causing lower or higher costs? Yes

Remarks: Boundary research and field location of evidence very time-consuming due to inferior records, boundaries not known to landowners, boundary compilation.

*MAILING LIST

1. Name and addresses of persons who should receive composite prints for review and comments:
Nobu Honda, Division of Forestry, Department of Land & Natural Resources, State of Hawaii, 1151 Punchbowl St., Rm. 325, Honolulu, Hawaii 96813

Date 7/3/81 Field Engineer [redacted] Proj. Engr. [redacted]

*For Advance Field Completion the Field Engineer and Project Engineer are to complete the items marked (*) and the Field Surveys Inspection Section is to complete the other items above.