Toward a Dynamic Atlas:

A Case Study on the Birds of the Venetian Lagoon

An Interdisciplinary Qualifying Project
submitted to the faculty of
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Abstract

This project, Toward a Dynamic Atlas, created a prototype for the *Osservatorio Naturalistico della Laguna* of an online dynamic atlas for the Venetian lagoon. This dynamic atlas possesses a species catalog, distribution maps for the birds of the lagoon, and a bilingual interface. A series of recommendations were made to the *Osservatorio* pertaining to which maps in the atlas would lend themselves to our dynamic system.

Executive Summary

Today's environment is rapidly changing due to various issues, many induced by man. There are several environments which exemplify this; one in particular is the Lagoon of Venice, in the Northern Adriatic. An ecosystem with many sensitive habitats and species, the lagoon is a delicate balance between erosion and sediment accumulation, as well as man and nature. Although humans have been affecting the lagoon for centuries, recently the effects have become more drastic, and now we must work to slow the changes that been allowed to easily transpire in the past. In order to restore balance, these variations must be tracked and their cause and effect must be identified.

For this purpose, the *Osservatorio Naturalistico della Laguna* was established in 2002 by the City of Venice in an effort to maintain a healthy lagoon ecosystem for the wildlife and human inhabitants. This organization is responsible for all information related to the lagoon, and is the ultimate environmental authority for the government concerning planning and urban development. As part of this task, the *Osservatorio* published the *Atlante della Laguna* (Lagoon Atlas) in 2004. The *Atlante*, which is mostly a compilation of data and statistics from various other specialized organizations, provides researchers at the *Osservatorio* with an authoritative reference on the lagoon environment. Paper atlases, such as the *Atlante*, have served as a vital means of cataloging information for years, however in today's electronic age, there is a demand for the information contained in atlases to be available in a quicker, more accessible medium. As such, the *Osservatorio* reacted to the changing times with *AtlanteWeb*, which is essentially an online reproduction of the

Figure 1: Evolution of *Atlante*

printed *Atlante*. It provides an excellent medium for patrons around the world to access information about the lagoon, its habitats, and its species. In addition, *AtlanteWeb* allows for some interactive capabilities, such as zooming and panning the hundreds many maps that are contained in the *Atlante*.

However, replicating information from atlases in a computerized format opens the possibility of displaying new data as it becomes available. This valuable tool could be used by researchers to realize imbalances in the lagoon ecosystem to help prevent major environmental catastrophes before they happen. Once again, the *Osservatorio* realized this opportunity for improvement and acted upon it. This is where the scope of our project begins. We were asked by the *Osservatorio* to create a prototype for a complete dynamic atlas by using the birds section as a trial. The avifauna section is ideal for a case study because bird populations are in a constant state of flux and are also excellent indicators of the overall health of the ecosystems that they live in. In addition, a wintering bird census is already performed annually in the lagoon between the *Museo di Storia Naturale* and the *Associazone Faunisti Veneti*, providing the group with real data sets going back more than ten years.

The process began by first meeting with representatives from the group's two main sponsors, the *Osservatorio* and the *Museo*. The main purpose of this initial meeting was to allow the design team to have a better understanding of exactly what features would help the sponsors to do their jobs more efficiently. The highlights of these requests included a bilingual interface, dynamically updated maps, and the ability to perform more complex analyses by viewing multiple layers of data on the same map. The requirements of the sponsors quickly led the design team to the concept of developing two separate web interfaces. The first interface would be mostly for the *Associazone* and would be used to update the data in the *Atlante*. The second interface would be used by *Osservatorio* researchers and patrons to view the data. In addition to displaying the most up-to-date data available, this second interface would also act as a means of displaying the accompanying text from the *Atlante* in either English or Italian.

After agreeing to a set of end user requirements, the design team could begin implementing the proposed design. The implementation phase of the project was undoubtedly the most time consuming and involved of all the phases, not only because of the extensive technical work that was required, but also because of the large volume of *Atlante* text that needed to be translated from Italian to English. Another important portion of implementation was testing. Therefore, during this phase, the group periodically tested the system for functionality and ease of use.

The result of our efforts is *Atlante dinamico*, which will be accessible from http://users.wpi.edu/~tomp/IQP until it is fully implemented. The site, shown in Figure 2 presents all of the maps and text from the current *AtlanteWeb* in a new style and in a bilingual format. In addition, it contains a comprehensive species catalog which has an entry for each of the birds found in the Venetian lagoon. This catalog also allows the user to view dynamically updated distribution maps that change immediately as new data becomes available. These distribution maps can also be superimposed in any user-defined combination with other maps from the *Atlante*. This powerful feature allows the user to perform complex GIS driven analyses that would have normally taken hours to implement.

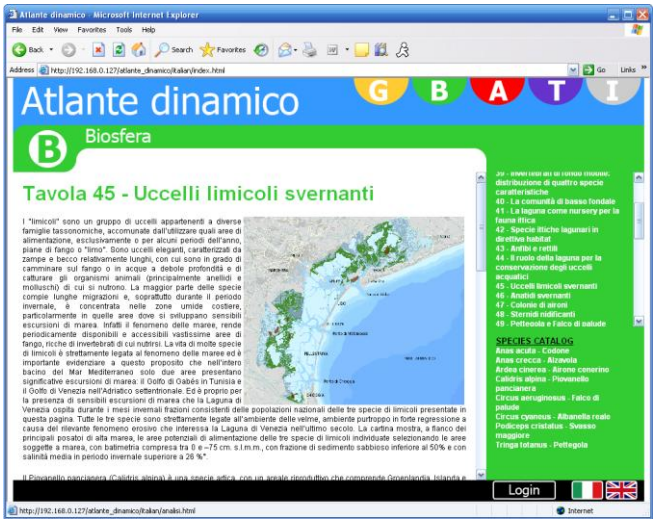

Figure 2: Atlante dinamico

All of the data sets for these dynamically updated features are supplied by the *Associazone Faunisti Veneti*. After performing the bird census, their data is entered into as online data entry form, which is accessible by the Login button on *Atlante dinamico*. Eventually, all of the organizations that contribute to the data in the *Atlante* will have their own forms that update the atlas in a similar fashion. Figure 3 shows the progression of data in a dynamic atlas.

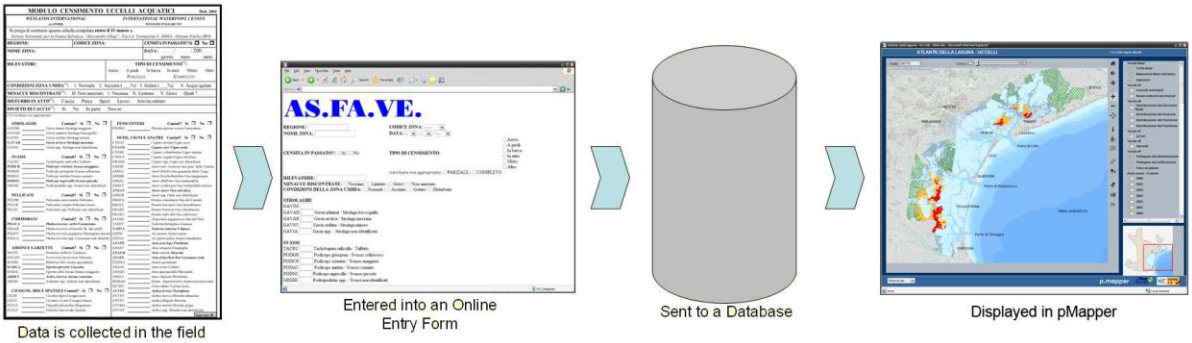

Figure 3: Data Flow in a Dynamic Atlas

Another objective of our project was to demonstrate to the sponsors the usefulness of a dynamic atlas. One of the biggest advantages to *Atlante dinamico* is that it automatically generates maps that can be used for subsequent analyses by researchers. Some of the maps in the *Atlante* are very complex and multivariate, and would normally take a skilled GIS technician several hours to

produce. However, *Atlante dinamico* automatically compiles even the most complex maps, which allows the user to quickly alter the parameters. This powerful feature makes it easier for researchers to predict what would happen to the lagoon environment if a certain aspect was altered, such as changes caused by major construction or re-routed water ways. In fact, these are some of the very issues that are presented to the *Osservatorio* by the Venetian government.

The last objective of our project was to make recommendations to the *Osservatorio* regarding which maps in the *Atlante* would lend themselves most to the dynamic medium. To do this we classified all 103 maps of the *Atlante* into one of three categories: (1) data that does not need to be updated dynamically, (2) data sets that should be updated every 5-10 years, and (3) data that should be updated as often as possible. Our group, in collaboration with Stefano Guerzoni, one of the project liaisons, has determined that 30 maps are static and do not require dynamic data entry, 45 change occasionally requiring new data every five to ten years, and 28 change frequently and would lend themselves to a dynamic atlas.

We then took this information one step further, identifying the organizations that contribute the most frequently changing maps to the *Atlante*. This resulted in a recommendation to contact the following four organizations: *Magistrato alle Acque di Venezia, Università di Venezia,* ISMAR, *Comune di Venezia*. These organizations all contribute multiple data sets to the most frequently changing maps in the *Atlante* and therefore should be the first agencies that are convinced of the dynamic atlas concept.

The greatest advantage for the *Osservatorio* to continue implementing the *Atlante dinamico* is that it would help them do their job more efficiently and effectively. Possessing a computerized representation of the exact state of the lagoon environment is a very powerful tool whose uses are almost boundless. However, it is important not to undervalue the primary beneficiary of our work: the environment of the Venetian lagoon. The implementation of a dynamic atlas would help the *Osservatorio* to better determine which urban development projects would have a significantly adverse effect on the Venetian environment and assist in formulating future plans to maintain the natural state of the lagoon. On the other hand, being able to better gauge the current state of the lagoon may give the *Osservatorio* more authority to approve other improvement projects, thus further benefiting the city of Venice and its citizens.

Authorship

This proposal was collaborated upon by Leia Houle, Matthew Nichols, Thomas Peterson and Joshua Stewart. In regards to specific contributions: Leia Houle provided background information on the history, species, and environment of the lagoon, as well as past avian flu research; Matthew Nichols researched past implementations of dynamic atlases and bird census data; Thomas Peterson wrote the section on Geographic Information Systems and maintained the web page; Joshua Stewart explained the roles of the *Osservatorio, Museo*, and the *Associazone*. The remainder of the paper, including the introduction, methodology and results, were entirely a group effort. While these sections could have originally been identified as being written by an individual group member, the final product has become an amalgamation of our thoughts and contributions.

Acknowledgments

Over the course of the project, the group has been assisted by a number of liaisons and advisors without whom this project would not have been possible. We would first like to thank the *Osservatorio Naturalistico della Laguna*, specifically Stefano Guerzoni. The access to their resources and the raw files from the *Atlante della laguna* helped us immensely. We would also like to thank Emanuele Masiero for taking time out of his schedule to aid Tom in the creation of our dynamic system. Next, we would like to thank Mauro Bon of the *Museo di Storia Naturale* and the *Associazone Faunisti Veneti*. The data, images, information, and general insight on the lagoon and its inhabitants he provided were priceless. We also cannot forget Daniela Pavan for everything she did for us. Her constant support was invaluable. Andrea Novello and Chris Vitone aided our group in overcoming numerous technical hurdles, without them we would have been stuck staring at a blank MapInfo window or buggy code. Finally, we would like to thank our advisors, Fabio Carrera and Scott Jiusto. Their time and effort, their sage-like guidance, all of this and more helped us see this project through to its completion.

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1 INTRODUCTION

The first geographical Atlas was published in Bologna, Italy in 1477, to facilitate trade on the Mediterranean;[1] and called the Ptolemy Maps, as the term Atlas was not coined until 1695.[2] After aiding travelers for centuries, the maps of static atlases evolved to incorporate various social and economic statistics, vegetation types, animal species, and water currents. This gave the public a better understanding of the world around them and how to care for it. These paper atlases were a vital means of cataloging information, but today a more digital approach is needed. The massive amount of information and the need to analyze this data has made the use of a dynamic system more important than ever. In today's society, an ever increasing emphasis has been placed on maintaining a healthy ecosystem. For example the extinction rate has recently grown to over 1,000 times the norm, a statistic which has certainly drawn attention to itself.[3] To keep up with the rapidly changing environment, dynamic atlases are becoming essential to maintaining a healthy relationship between nature and urbanization.

The *Osservatorio Naturalistico della Laguna* was established in 2002 by the City of Venice in an effort to maintain a healthy lagoon ecosystem for the wildlife and human inhabitants. This organization is responsible for all information related to the lagoon, and is the environmental authority for the government concerning planning and development. As part of this task, the *Osservatorio* published the *Atlante della laguna* (Lagoon Atlas) in 2004. The *Atlante* provides researchers at the *Osservatorio* with an authoritative reference on the lagoon environment, and also provides a medium to communicate their findings.

Agencies worldwide, which can act as an example for the *Osservatorio,* have begun taking the necessary steps to better serve the needs of scientists and researchers. One such step was to create a resource that is constantly updated and more useful. These agencies have created computerized atlases which contain dynamic information. Not only does a computer provide an easier means of updating and accessing the information, but it allows for sophisticated analyses to be performed very easily. For example, organizations in Washington D.C. and Oregon have developed databases that feature GIS maps that are updated as new information becomes available. A system similar to this would provide Venetians with a highly sophisticated tool with which to monitor their lagoon.

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[1] G.H. Beans, *Notes on the Cosmographia of Ptolemy, Bologna.*
[2] G.H. Beans, *Notes on the Cosmographia of Ptolemy, Bologna.*
[3] http://rainforests.mongabay.com/0908.htm

While previous work has been done on the *Atlante* in order to computerize and update it by creating the *AtlanteWeb,* this atlas still exists solely in the form of a static database that must be updated via paper-based forms. The information contained in the *Atlante* is only updated when a new version is published, which can take months or even years. For most fast-spreading environmental threats, such as infectious diseases, pollution, and global warming, this process is not adequate for preventing catastrophe before it happens. Although the static form has served Venice well over the years, the time has come for interactive media. Obviously, with the Venetian environment so threatened, the process of entering the data and displaying it in an updated atlas must be streamlined to produce almost instant updates.

This project will provide the *Osservatorio* with a dynamically updated, computerized database that displays new information as soon as it is entered. The universally accessible system will be useful to ornithologists and the general public alike. Our project is intended to help the *Osservatorio Naturalistico della Laguna* by modernizing their bird population database to create a foundation for a complete dynamic Atlas. This project will aid environmentalists at the *Osservatorio* by providing a system that will help analyze and keep track of the statistics of the Venetian environment. Monitoring bird activity will provide a diagnostic tool for experts at a time when threats to the Venetian lagoon are at the forefront of public concern.

2 BACKGROUND

Before fully embarking on the topic of creating a dynamic atlas for the *Osservatorio*, it is important to take a step back to become better informed in all the fields that this project will encompass. The first step in this background research was to become accustomed with the geographic region that the project will be conducted in. The *Osservatorio's* Atlas was a very useful tool to identify the habitat and species that one should expect to observe in the Venetian lagoon. It was also interesting to research the developmental history of the Atlas itself since the purpose of this project is to help the Atlas evolve and adapt to new technology. Included in this proposal, the reader will find a brief history of the *Osservatorio* itself and some information regarding the environment with which the *Osservatorio* is concerned.

Figure 4: Arial View of the Venetian Lagoon

Another key piece of background research presented involves specific information about how Geographic Information Systems work. This is very important for the reader to know because this project will be involved very heavily with GIS, and having a good working knowledge of how it works is very advantageous. Finally, a variety of case studies are presented on how other environmental agencies have applied GIS systems to help make their jobs easier. This is necessary because it provides a good idea of what is actually possible, and what could actually be of significant help to the *Osservatorio*.

2.1 The Venetian Lagoon

Knowledge of the lagoon and its inhabitants is crucial in providing a base for the purpose of this project. The current Atlas focuses on the lagoon, and therefore to update this system and utilize it properly one would need to know the basic facts of the lagoon; what its status has been, and where that state is going. Such information is vital in determining what is important to analyze, which species best represent the lagoon environment and factors which may affect the health of the

lagoon. In establishing these facts, we are better equipped to understand the overall impact of this project and able to act upon newly retrieved information.

The Venetian lagoon is a rich environment full of wildlife and constant change. This ecological wonder is located in Northeastern Italy, along the Upper Adriatic Sea, and provides the marshy islands upon which the great city of Venice is built. Its crescent stretching along the shore from the mouth of the southern Po River to the northern Piave River, the lagoon covers approximately 550 square kilometers, with an average depth of 2 feet, and about 80% is composed of salt marshes and mud flats, only 8% being permanent land.[4] With constant feed from the rivers, and flushing by the sea, the water is a brackish mixture holding a delicate ecosystem dependent on tides, equilibrium between erosion and accumulation, and the influence of man.[5]

2.1.1 History

The early formation of a lagoon is due to organic and inorganic particle build-up from river outlets and washing by waves. Depending on which source carried more sediment, the lagoon could accumulate material and become land, or be negative in sediment and give way to a marine environment. In the case of the Venetian lagoon, sediment from the river mouths built up and silted the water enough to create islands. However, the Venetian lagoon environment is more of a balance between the two states. Accumulation and erosion balance each other, creating a half land, half marine environment which is unstable and very delicate. This constantly changing environment could easily benefit from monitoring provided by a dynamic atlas, especially with the human presence exacerbating the situation.

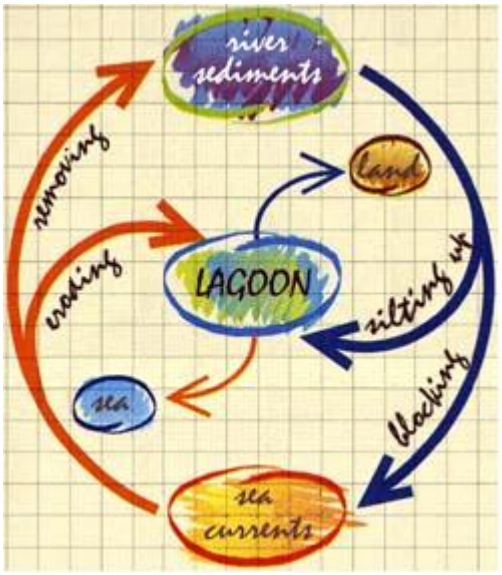

Figure 5: Formation of a Lagoon

The delicate lagoon has been offset by the influence of man for hundreds of years. In the beginning of the 14th century, the Lagoon was for the most part in its original form, with the mouths of many rivers emptying into it, including the Brenta, Bacchiglione, Sile, and Piave. When the 14th

[4] *Venice,* <http://en.wikipedia.org/wiki/Venice>.
[5] *The Lagoon of Venice,* <http://www.salve.it/uk/banchedati/f-domande.htm>.

century was in full swing, operations began to divert the river Brenta, seen as the main cause of silting the lagoon, which was not desirable. The silting of the lagoon lowered the overall depth of the area, making boat travel more difficult and treacherous. Such diversion continued into the 15th century with the construction of the Canale Maggiore, bringing the Brenta progressively farther from the lagoon. It was then argued that the cause of the swampy regions and silting were due to the rivers; projects then began to divert all river mouths from the lagoon basin. The argument was that by doing so, travel of ships through the inlet of Malamocco would increase trade with Venice. Such projects continued, and included more canals, barriers and manmade lakes, all to maintain a boat-worthy lagoon and retain the "too shallow for invading ships, too deep for marching armies" character.[6]

One of the biggest projects included a sea-wall defense, built in the 18th century it protected the lagoon from rough tides along the coastal strip. By the 19th and 20th centuries, many jetties, bridges and ports had been completed. The jetties influenced currents and allowed for more efficient trading routes. Large fish farms had begun in the northern and southern regions of the lagoon and industrial influence was prominent. By the end of the 20th century, several projects to reclaim areas of the lagoon for industry were underway. This reclamation involved using land from previous projects to fill in sections of the lagoon to develop upon. An oil tanker channel was built, the Tessera salt marsh region was reclaimed to build an airport, and a bridge was built that connected Chioggia to the mainland. Presently, society has begun to realize the damage this "reclamation" of the lagoon has done to the wildlife and ecosystem. Re-naturalization projects have been performed to restore the natural lagoon. Today, the concern is less on pure development and more on completing projects that will benefit man without harming the natural state of the lagoon.

2.1.2 Bird Habitats of the Lagoon

The lagoon in its natural state has several main habitats full of various life forms. The coastal environments and beaches that border the Adriatic used to house many valuable fauna. But as of today, commercialism and tourism have turned the beaches away from natural conservation and the wildlife content there is severely threatened.[7] The open water of the lagoon consists of shallow sections with the deeper sections marked for the passage of boats, and the occupants consisting mainly of fish and birds. These aquatic birds are the most representative species of such

[6]Fletcher, Caroline. *The Science of Saing Venice*. 22-23.
[7] Musu, Ignazio. *Sustainable Venice: Suggestions for the Future.* 31.

wetland communities and are usually termed "avifauna" to stress their ecological dependence on the environment.[8] Some of the more important habitats include the shoals, which are sandy shallows exposed during low tides. They are rich in wildlife, including fish trapped by the receding water, crabs, crustaceans, and other small invertebrates, all of which draw the attention of predators, mainly birds. The varieties of the birds attracted to the shoals consist mainly of waders, who skim through the sand with their long beaks in search of food. If the shoals are the buffet of the lagoon, the salt marshes and reed beds are the homes.

The salt marshes, which are larger in number than the reed beds, consist of semi-firm, muddy ground covered in vegetation consisting of grasses and small, dense bushes which provide excellent hideaways for most of the lagoon's larger animals. Considering there are very few mammals in the lagoon, the salt marsh's main occupants consist of amphibians and birds, who find the mud and vegetation perfect for nesting. The reed beds are similar in stability to the salt marshes, though their vegetation is made up of reeds or long, sectional plants similar to very stiff grass. The reeds provide a similar environment as the salt marshes, with considerable cover for animals to house their nests.

The final habitat to be considered is man made: fish farms, which started as man taking advantage of the natural channels of the lagoon, and became industrialized with artificial water ways and mechanisms. More popular in the 1970s on the local level, fish farms now provide a market consisting mainly of exports to the mainland and beyond.[9] The channels of these farms , as shown in Figure 6, are designed to lure fish in to lay their eggs, allow them to grow, and ultimately built so that once they are in they cannot get out. Often well maintained and closed off to the public, they provide a home for fish, a food source for man, but also nesting grounds and feeding areas for many birds, including most gulls and ducks. The owners allow the birds to stay on their farms, but they often take advantage of them through hunting. Although this

Figure 6: Arial View of a Fish Farm

[8] ibid, 58.
[9] ibid, 45.

presents a threat, the many birds that are not hunted are given a very closely monitored habitat in which to live.

The habitats that make up the Venetian lagoon and its inhabitants make it of local, national and global importance. On a local level the lagoon provides food and a home for the animal, as well as human occupants. On the national scale the lagoon plays a crucial role in that it is the most important wetland for wintering birds in all of Italy. As Figure 7 shows, the greater majority of Italian birds utilize the Venetian lagoon as their home in the winter. The importance rises to a global level when one considers the RAMSAR convention and what was determined there. The RAMSAR convention is an annual gathering which determines wetlands of global importance. To be considered at this level, a wetland needs to house at least 1%, or 20,000 individuals, of the global population of any bird species. It has been determined that the Venetian lagoon houses at least 1% of ten different species of bird, achieving ten times the minimum needed to be considered of RAMSAR ranking. Achieving such a level not only makes the wetland acknowledged worldwide, but allows for appropriate protection and funding from the mother nation. Currently, the Italian government has chosen not to recognize the lagoon's status, making life difficult for those trying to save this ecological gem. Therefore, despite meeting and exceeding RAMSAR standards, the lagoon of Venice is not on the list of wetlands of international importance, save for 200 hectares of the refuge at Valle dell'Averto.[10] Keeping that in mind, it is clear how important the lagoon is, and that every measure must be taken to maintain the land which is home to so many.

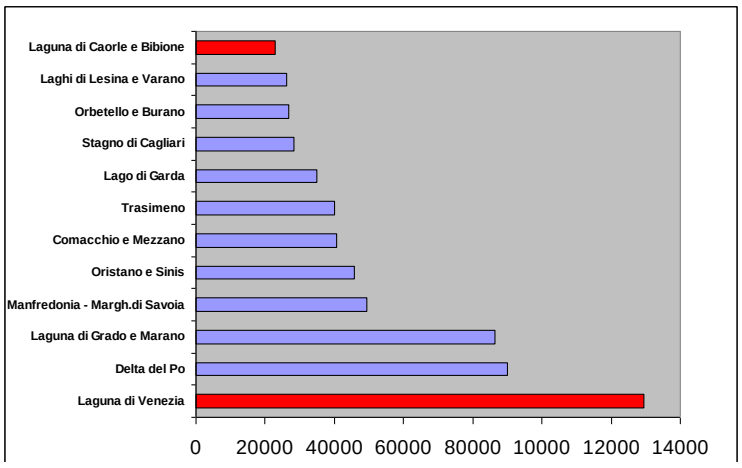

Figure 7: Bird Distribution in Italy

[10] ibid, 54.

2.1.3 Avian Influenza

The environmental impact of this project is clear: the development of an interactive database will allow for quicker assessment of bird health and overall lagoon status, making assessment faster and easier, thus allowing for better environmental decisions to be made. When originally embarking on this project, it was assumed that its influence would have an even broader range. At the time it was not known how crucial world events were to those concerned with the lagoon, and considering the recent outbreaks of avian flu, research was done on the topic and its importance. Upon arrival in Venice, it was made clear that avian influenza not a concern, even if it was another agency would handle it. Therefore, the application of the project to help appears unlikely, though it could still be applied. The dynamic atlas will grow to be a very valuable analytical tool and could be useful in such a crisis.

2.2 Associated Agencies

A key component of this project was to collaborate and coordinate cooperation between several different agencies. Most of the organizations already had an established working relationship, and it was our task to fit seamlessly into this affiliation while still achieving our goals and objectives. As such, it is very important to have an idea what each organization is responsible for and some history about their most influential past projects. The two main sponsors of the project were the *Osservatorio Naturalistico della Laguna* and the *Museo di Storia Naturale*. A third organization, the *Associazone Faunisti Veneti* also played a crucial role in the success of our project.

2.2.1 Osservatorio Naturalistico della Laguna

The *Osservatorio Naturalistico della Laguna* was created by [illegible]tee of Venice in January of 2002. The government needed a decisive authority that they could turn to regarding decisions that would have environmental consequences on the lagoon of Venice. The *Osservatorio* would fill this void for the government and would be recognized as the premiere authority on the Venetian lagoon environment. The *Osservatorio's* offices are currently housed in the *Casa della Laguna*, pictured in their logo in Figure 8.

Figure 8: Osservatorio Logo

The first task of the *Osservatorio* is data collection and assimilation, which gives them a basis for future decision making. Using the data they collected, they can make educated suggestions about human alterations to the lagoon and its biospheres.[11] With time, the *Osservatorio's* role was to initiate a series of restrictions on environmentally detrimental urban development within the lagoon, including evaluation of the environmental impact of the MOSE project.

The MOSE project represented the first time that the *Osservatorio* was placed squarely in the public eye. This project was, and continues to be, a highly debated topic in the city of Venice which plans to construct a series of water-doors or flood gates that would block extremely high tides and storm surges from entering the lagoon, and therefore the city of Venice. Presumably, constructing man-made flood gates could have a negative impact on the balance of the lagoon ecosystem. Additionally, the actual construction of the gates would introduce a great deal of disruption to the environment and species that live there, causing the project and its outcome to be of great concern to the *Osservatorio*. The increased focus on the environment has thus made the *Osservatorio* widely known among the citizens of Venice.

[11] *Osservatorio Naturalistico della Laguna.* <http://www.ambiente.venezia.it/osservatorio.asp>.

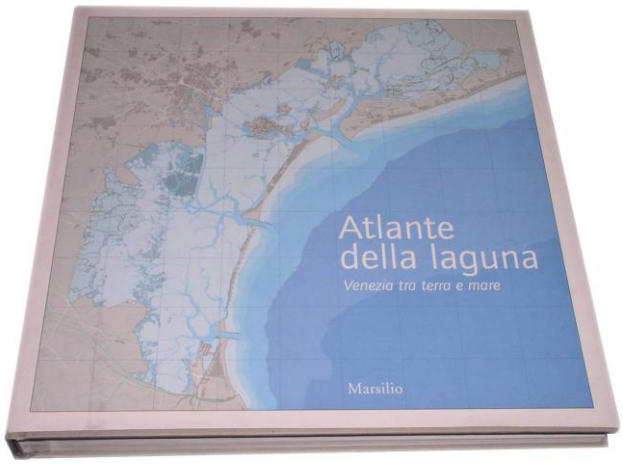

Figure 9: Atlante della laguna

2.2.1.1 Atlante della laguna

One of the first projects the *Osservatorio* took on after their commissioning was the creation of a lagoon Atlas. This Atlas serves two purposes. First, it would internally provide the workers and researchers of the *Osservatorio* with a decisive resource on the statistics of the lagoon ecosystems. Second, it allows for the *Osservatorio* to distribute their knowledge so that people worldwide could better understand the environment around them. In 2004, the first edition of the *Atlante della laguna* was published. The centerpieces of this beautiful book are the 103 full color maps, containing a wide variety of information about the lagoon environment. On the opposite page of each map is a full text description of the map and the data's implications for the environment. With the creation of these maps and organized lists, abnormal occurrences in the lagoon could be more easily identified and dealt with.

Although some of the information contained in the *Atlante* is proprietary to the *Osservatorio*, the majority of the data is compiled from approximately 50 other contributors, including the *Museo di Storia Naturale*, another one of this project's sponsors.

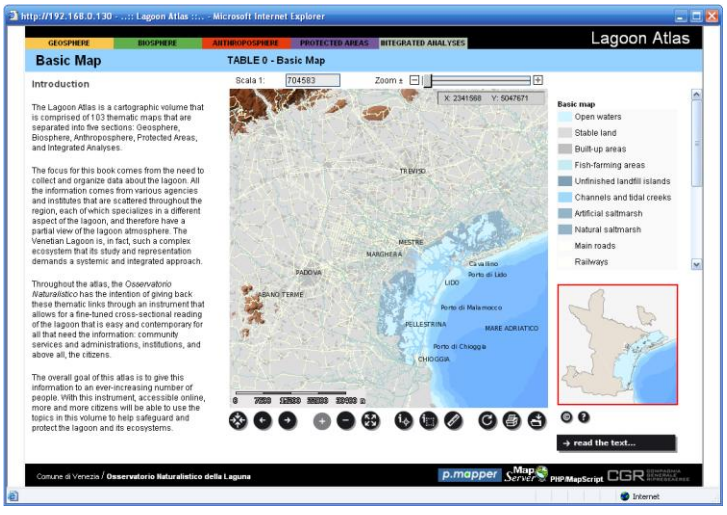

Figure 10: AtlanteWeb

2.2.1.2 AtlanteWeb

To increase the functionality of their atlas, the *Osservatorio* created *AtlanteWeb*, shown in Figure 10. This site, which utilizes an open-source mapping application called pMapper, contains some of the maps from the Atlas, and more are currently being added. For the tables that are present, one can find the map and the text in

Italian. The map itself is the same as the one in the *Atlante*, but in the interface it is possible to zoom in and pan around. This allows for a more in-depth view of the data.

2.2.2 Museo di Storia Naturale

The *Museo di Storia Naturale* was founded in 1923 thanks to the dedication of Giorgio Silvo Coen. It was Coen's inspiration that resulted in the *Museo Correr*, *Istituto Veneto di Scienza*, *Lettere ed Arti*, and several other smaller private collections being housed under one roof. Since 1923, the *Museo* has resided in the *Fondego dei Turchi*, which was initially built as a palace for the Pesaro family in the early 13th century.[12]

Today, the *Museo* serves multiple roles to the city of Venice. The museum maintains several entertaining and educational exhibits that are geared toward both tourists and citizens. For example, the largest draw these days to the museum has been its dinosaur exhibit, a collection of fossils and relics that were recently discovered in Africa.

Perhaps the most important role of the *Museo* for the purpose of this project is the fact that it supplies the *Osservatorio* with eight data sets for maps in the *Atlante*. In addition to these eight data sets, researchers at the *Museo* contribute a great deal of the text included in the *Atlante*. However, in some cases, the *Museo* helps other organizations to collect data also provided to the *Osservatorio*. In the case of the five bird maps, the *Museo* works in collaboration with the *Associazone Faunisti Veneti*.

2.2.3 Associazone Faunisti Veneti

The *Associazone Faunisti Veneti* was founded in 1994 by scientists and researchers at the *Museo*. This volunteer organization's main purpose is to perform an annual wintering bird census on the Venetian lagoon.

[12] *Museo Civici Veneziani*. Dec. 4, 2006. <http://www.museicivicive neziani.it/frame.asp?musid=5&sezione=musei>

2.2.3.1 The Annual Wintering Bird Census

Every January, over a period of three days, the volunteers of the *Associazione Faunisti Veneti* perform a wintering bird census that covers the entire province of Venice, including its lagoon. The census is performed in full accordance with the International Waterfowl Census (IWFC) standards. The IWFC defines for each participating area a map of the area to be counted. The map is divided into several zones, determined by habitat type and other geographic references (such as rivers, cliffs, etc.). Each zone is then assigned a location code in the following format: "VE0900." The VE, for Venezia, does not change throughout the lagoon but each zone is assigned a sequential number. The volunteers break up into smaller teams, usually two or three volunteers per group, equipped with one IWFC certified ornithological expert, and count the birds in a specific zone. Such excursions are performed on foot, by boat, or by aerial fly-bys. Figure 11 shows the lagoon of Venice divided up into the zones defined by the IWFC.

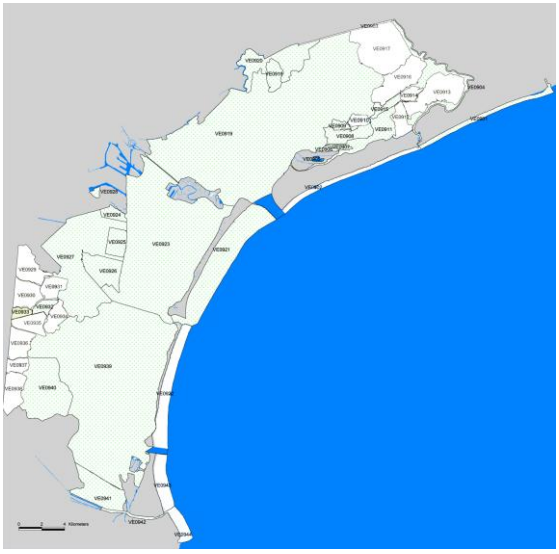

Figure 11: Lagoon Divided by IWFC Codes

The expert can quickly identify almost all of the birds that are expected to be seen in the lagoon, though a manual is often brought along. The other team members assist the expert, such as assisting in counting large flocks of birds. Each species of bird seen in the lagoon is documented with a picture, and very large flocks can also be counted by taking a photograph via plane and counting the exact number. Each team is also given a field form to record their counts. There is one form turned in for each zone. Appendix **Error! Reference source not found.** shows the blank form that was used in the 2006 census. After the census is taken, the researchers at the *Museo* are assigned the task of analyzing the data and writing an annual report stating their findings.[13]

2.3 Web Based GIS and Past Implementations

This project represents a digital step forward for the city of Venice. Currently a static atlas exists, as well as a skeleton for a digital database; the final step is a web-GIS system. This project

[13] Personal interview with Dr. Mauro Bon, *Museo di Storia Naturale*. Nov. 9 2006.

provided the base for an interactive, dynamic atlas, but in order to see where we are going, we must remember where we have been. Being familiar with the formation of this technology, and what has been done in the past, provides many lessons for developing a functioning, efficient system. Seeing how it was developed can inspire new jumps forward and knowledge of previous achievements (or lack there of) allows us to learn from mistakes. Thus, information on web-GIS and its past implementations are crucial in achieving the ultimate goal of this project: a functioning, interactive GIS database.

With the advent of the personal computer, cartographers began to realize the possibilities that awaited them through the use of these new powerful tools. In recent years technological developments have led to a decrease in prices of electronic mapping software and hardware, opening up even more possibilities for electronically based atlases.[14] One of the greatest benefits of electronic mapping is dynamic presentation, which when applied to atlas-making is even more useful. Dynamic atlases can be used to instantly display the simulation of various scenarios and give the implications of certain environmental decisions.[15] Thus, a dynamic atlas would provide the *Osservatorio* with an excellent tool to do their job. In addition, the GIS maps that a dynamic atlas would be able to produce would help the *Osservatorio* to more quickly and effectively communicate the implications of a decision to those who are most directly affected by their advice (mostly politicians and citizens).

Fortunately, there are a number of other cities, regions, and even entire countries that have created PC-based atlases from which the *Osservatorio* can duplicate and/or improve upon. The first computer-based electronic national atlas was made for Canada and was released in 1986. As would be expected from most innovative software, the system contained some very helpful new features and tools, but also exposed several new weaknesses and deficiencies in the technology. Since the release of the *Electronic Atlas of Canada*, several other countries have followed suit with their own national atlases, such as Austria, China, Japan, and the United States.[16]

2.3.1 Definition of GIS

To create the base for this dynamic atlas, we will be mapping using Geographic Information System (GIS) software. More specifically, we will be using a web-based version that allows for real-

[14] J.S. Torguson, *PC Based Animation for Geographic Education*, 53-55.
[15] B. Rystedt and E.M. Siekierska, *Technical and Organizational Approaches to National and Regional Atlas Production*, 13.
[16] B. Schneider, *Integration of Analytical GIS – Functions in Multimedia Atlas Information Systems*, 3.

time updates over the internet, commonly referred to as web-GIS. In general, a geographic information system is defined as having these four essential subsystems: data input, data storage and retrieval, data manipulation and analysis, and data reporting. To be considered a true geographic information system, software must possess and perform efficiently in all four of the listed components.[17] While that gives a brief idea of what describes a Geographic Information System, it is helpful to understand where GIS came from and why it was developed in the first place

2.3.2 Specifics of Web-GIS

A significant development in GIS was the advent of the Internet. Whereas previous traditional systems were closed and centralized, the use of the Internet brought about distributed geographic information systems that "can connect to and interact with multiple and heterogeneous systems and servers at the same time and without the constraints of traditional client/server relationships."[18] There are many variations of distributed GIS, but all are a means to access GIS information and process it over the Internet. The specific technology we are interested in, however, is web-GIS. Web-GIS is special in that it uses the World Wide Web, which is a networking application supporting a HyperText Transfer Protocol (HTTP) that runs atop of the Internet. In simple terms, web-GIS operates on top of a web site rather than in its own separate program. Also, the data on this site must be dynamic and can be manipulated or examined using an array of tools available to the user, not simply a static map generated from another GIS implementation put on the Web. Web-GIS should also not require that the user have GIS data and software installed locally, and should be able to be cross-platform accessible.[19] The goal of web-GIS development is to make a universally accessible system that can be updated and manipulated in real-time, allowing for constant data additions, revisions, and analysis.

2.3.3 Approaches to Computerized Atlases

Currently, there are three distinct approaches that have been used to integrate GIS maps with multimedia interfaces. The first, and simplest approach, is typically referred to as "Multimedia in GIS" and involves modifying commercially available GIS software to create a more user friendly dashboard to operate the software. This type of system is most commonly used by GIS developers

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[17]Donna J. Peuquet and Duane F. Marble, *Introductory Readings in Geographic Information Systems*, 10.
[18]Zhong-Ren Peng and Ming-Hsiang Tsou, *Internet GIS: Distributed Geographic Information Services, 9*.
[19]Peng and Tsou, 10-15.

to produce urban and environmental decision support systems, just like the decisions the *Osservatorio* is asked to make.[20] The second approach has been coined "GIS in Multimedia." This technique is much more advanced than "multimedia in GIS" because you are not restricted to the limitations of commercial GIS software. Everything in a "multimedia in GIS" Atlas is custom made to tailor exactly what information you want to get out of the Atlas and how you want it to be displayed. Recently, other countries, including the United States have made computer atlases based on the "multimedia in GIS" style. The third method is called "GIS and Multimedia Cartography." This newest system was proposed by H.R. Bär and R. Seiber in 1999 specifically for the purpose of creating multimedia, interactive atlases. Their approach allows for optimal visualization, while also facilitating elementary GIS functions that were commonly left out of previous methods.[21]

2.3.4 Applications of GIS

Geographic Information Systems can be used in various ways and can cover a wide variety of topics. The user base for the systems can differ and merit distinct tools for the identified end-user. GIS can display just about any geographic information that can be recorded, whether it is topographic information, woodlands density, natural resource locations, animal populations, or almost anything you can think of. As long as the information can be recorded correctly, it can be displayed if it possesses the necessary location coordinates. Data within a geographic information system is made up of three conceptual components, as shown in Figure 12. It can be seen that for a single piece of data, the information the system requires can be very intricate. The complexities required add to the analytical power of GIS, since it can not only present the user with intricate details to analyze but, in some cases, it can use various algorithms to analyze the data itself. For instance, if you wanted the system to show the decline in bird population from year A to year B, it could simply take the two fields, compare them, and output

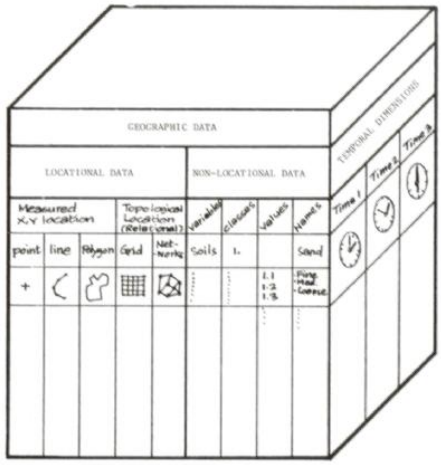

Figure 12: Conceptual Components of GIS Data

[20] J. Blat et al., *Designing multimedia GIS for territorial planning: the ParcBIT case*. 670.
[21] B. Schneider, *GIS Functionality in Multimedia Atlases: Spatial Analysis for Everyone*, 1.

an overlay based on what it finds. Specific data is not always required depending on the complexity of the system.[22]

The dynamic atlas we aim to implement using web-GIS will primarily focus on the bird populations in order to show that the system could be an effective means to display the current atlas' data. GIS allows for spatial representation of the data collected, much like a paper atlas does, while being maintained with constant digital updates.[23] Using a data collection process similar to those in previous years, data will be gathered that possesses all the conceptual components of GIS which includes location data (measured x, y location and topological location), non-location data (variables such as bird population at the location), and temporal dimensions (time at which the data was gathered).[24]

2.3.5 The Atlas of Switzerland

Venice is not alone in their venture to create a dynamic atlas; many other countries have already established a system, or are also traveling through the developmental stages, which can serve as examples to guide the Venetians through their venture. For example, the *Atlas of Switzerland* has been the model of interactive, GIS Atlases for the past ten years. The Swiss Atlas contains over 1,000 interactive maps that cover everything from weather and climate to flora and fauna.[25] Switzerland has been distributing versions of their National Atlas in printed form or on compact disc since 1997. The computerized atlas, which started out in the "multimedia in GIS" type described in Section 2.3.3, was improved in 2000 to the latest approach in multimedia atlases, the "GIS and multimedia cartography" style.[26] The Swiss Atlas has always been one of the leading atlases in the world, and their innovative switch to the newest technology displays their commitment to using technology to track the environment around them. However, even the Swiss have not developed a truly dynamic atlas up to this point. As of right now, you can download updated versions of their multimedia atlas periodically from the Internet, but it is still not a truly dynamic resource. But, the Swiss Federal Institute of Technology is currently working on a project that will allow the Swiss Atlas to be accessed directly over the Internet, taking one step closer to a true dynamic atlas.

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[22] Peuquet and Marble, 34.
[23] Laurel Doherty, Katherine Mucci, and Mark Vignali, *Place Knowledge: Organizing data on The Venetian Lagoon Park*, 61-64.
[24] Peuquet and Marble, 34.
[25] *Atlas of Switzerland.* <http://www.atlasderschweiz.ch/index_en.html>
[26] P. Ögren, *The new PC-Atlas of Sweden*, 2262-2267.

2.3.6 Regional Specialized Atlases

Creating a complete Atlas for a geographical area as large as the country of Switzerland is not within the immediate scope of our project, which is to create a base, for larger things to grow upon. We may be able to learn from some of the techniques and methodology that they have applied in Switzerland and other countries, though currently it is more practical to put most of our focus on smaller scale projects that are more closely related to our specific task; cities, national parks, mountain ranges, etc.

In most cases, it is hard to find information on complete multimedia atlases that cover just a small region of land, such as a city or national park. To produce an atlas on any scale is no easy task. It is especially difficult for smaller geographical regions (cities, towns, or state parks) because usually funding is very limited. Thousands of man hours and even more money must be contributed before the data collection can even begin. Therefore, a complete atlas that contains information regarding the entire ecosystem of an area is extremely hard to find. Furthermore, finding a complete computerized atlas of a small area is difficult because creating and maintaining a multimedia atlas is significantly more expensive than developing a paper-bound version. Although sometimes cheaper to maintain and keep up to date, the overhead for development is what scares most organizations from the computerized medium. There are examples, however, which shed hope on this situation and can serve to inspire the *Osservatorio* in their endeavors.

2.3.6.1 Oregon Coastal Atlas

One example of a complete atlas that we found was the Oregon Coastal Atlas (OCA). The Atlas was developed with collaboration between the Oregon Ocean Coastal Management Program, Oregon State University, and Ecotrust. The target of this particular online Atlas is a wide variety of users, from coastal managers to researchers, and even the general public. The Atlas project was initiated in an attempt to aid the government with visualization and interpretation of environmental decisions made in the coastal region of Oregon.[27] The information stored in the Atlas is very specific, complying to all the rules and regulations set forth by the Federal Geographic Data Committee (FGDC). The FGDC is a committee that was organized in an effort to standardize and coordinate the distribution of geospatial data on a national scale.[28]

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[27] Tanya Haddad, et al., *The Oregon Coastal Atlas*, 2.
[28] *FGDC Homepage*, < http://www.fgdc.gov/>.

The Oregon Coastal Atlas, however, distinguishes itself from other FGDC Atlases not only with its web-based interface, but also because of it's the innovative application tools that it features. The OCA consists of three main sections: "search", which returns datasets and maps you would expect from an interactive Atlas, "learn", which is a simple database of other relevant environmental information, and "tools" which contains an interface designed to help the user apply all the information learned and solve the problem at hand. The "tools" section is particularly innovative, as it can simulate environmental situations quickly and easily. For example, the system can determine whether or not a coastal home will erode away after 20 years under certain environmental variables. This data is commonly evaluated by environmentalists, and this system is particularly useful because it gives the common citizen or politician that power as well.[29] The Oregon Coastal Atlas is an excellent example of what a dynamic atlas is capable of, given time and energy. In addition to atlases such as this, there exist others which are more specific and provide a perspective valuable to the goals of this given project.

2.3.6.2 Washington D.C., Project Birdscape

In the cases of small regions of land, it is much more common to find an atlas that tracks one certain aspect of the environment, such as soil, vegetation, or birds, which can act as a base for larger things to come if necessary. These specialized records usually exist thanks to the largely volunteer efforts of interest groups such as the National Audubon Society or World Wildlife Fund. In the majority of these projects, the purpose is to fulfill some sort of research goal.

The most relevant past implementation of a GIS based bird population monitoring system was located in Washington D.C. The project and its specifics were documented wonderfully in a collaborative report named "A citywide breeding bird survey for Washington, D.C." The project, nicknamed project "Birdscape" was a collaboration between the Audubon Naturalist Society, the National Park Service, and the National Biological Survey. This prototype system for monitoring urban bird populations began in 1993, when the first documented bird census was taken on the Washington D.C. area. The main purpose of their research was to determine if certain bird species had an affinity towards different types of land use patterns throughout the city. Although the report only discussed the analysis with respect to land use, many references to the advantage of GIS that other layers of data can easily be imported and further analyses performed.

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[29] Tanya Haddad, et al., *The Oregon Coastal Atlas*, 4.

First the Washington D.C.'s Office of Planning's sixteen different land use categories were simplified into seven and entered into their own GIS layer. The categories established for the purpose of the Birdscape project were: low, medium, and high density residential, commercial, institutional (universities, corporate campuses, etc.), parkland, and industrial. Another GIS layer was then created with census points spaced at 500 meter intervals throughout the survey area. Then a team of over 100 volunteers went out to the various points and took a census at each point. The Birdscape project used the widely accepted five minute point count method for taking bird censuses. This method requires the birdwatcher to stay in the same spot for five minutes and record every bird seen or heard. The point counts were all taken during the same time of year and under optimal weather conditions. If one of the census points was in the middle of a body of water or was otherwise inaccessible, the point was disregarded.[30]

Using precisely positioned census points through GIS mapping allowed for the researchers to compare the bird population data geospatially to the land use data. The results were convincing that there exists a complex relationship between urban bird habitat affinity and species richness, number of birds, and habitat structure. However, maybe the most useful piece of information that we can gather through project Birdscape is that GIS can in fact be used to store collected bird census data, analyze that collected information, and effectively share it with various agencies. This exemplifies the ultimate goal of our project for the *Osservatorio*.

[30] C.J. Ralph, Designing and implementing a monitoring program and the standards for conducting point counts, 204–207.

3 METHODOLOGY

This project was intended to help the *Osservatorio Naturalistico della Laguna* create a foundation for a complete dynamic Atlas by creating a prototype for the system. The avian fauna section presents a favorable case study for this task, as bird populations are in a constant state of flux, and are a good indication of the health of the lagoon.

The objectives of this project were to:

- design and implement an efficient, user friendly system for managing bird census data
- test the functionality of the system by entering data and surveying the targeted user base
- demonstrate the usefulness of the system
- determine other data sets currently in the atlas that could benefit from our work

This chapter outlines our project goals and the tasks that were associated with them. Our goal was to provide a suitable foundation for an online, dynamic version of the current *Atlante della laguna* by creating a system involving the bird populations of the Venetian lagoon. While our wish was to create a system that could be applied to all aspects of the atlas, our primary focus remained solely on the avian fauna section. Figure 13 shows the periphery of where our project took place, the Venetian lagoon.

Figure 13: Spatial Boundaries

To go about our project we first designed a database, using previous work as our basis, which created a streamlined process of data collection, input, output, and analysis. Our data collection methods were shaped by the current processes in place, past implementations we had found, and the input and feedback of the *Associazone Faunisti Veneti*. The framework of the system itself was designed to our specifications by CityLab. After our design was implemented, we went on to a testing phase in which we not only rigorously assessed the system but also gathered input from potential users on whether it fits their needs in its current state. Finally, a demonstration of the system's usefulness occurred after we were sure the system met

specifications. Our group's intention was to show that a dynamic atlas could generate the same product as the *Atlante della laguna*, as well as provide researchers and other users with other valuable tools for analysis.

3.1 Designing a System for Managing Bird Census Data

This was perhaps the most involved and labor-intensive step of the entire project because developing the database itself was a culmination of all the performed background research. For this part of our methodology we adhered to the "Waterfall Model", shown in Figure 14, which outlines the logical process for software engineering. The process is named the waterfall model because the results of each step are used and required by the next step.

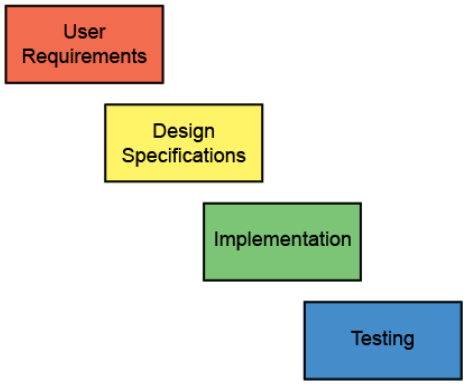
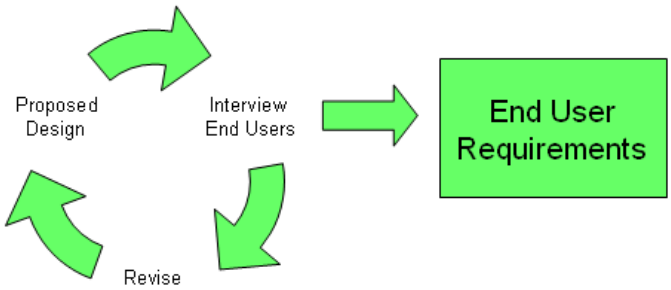


Figure 14: Waterfall Model for Software Design

3.1.1 Determining End User Requirements

Before any actual design work could be started, it was very important to establish open lines of communication between the design team and the end users. For our project, the end users consisted of the *Osservatorio Naturalistico della Laguna*, *Museo di Storia Naturale*, and *Associazone Faunisti Veneti*. This allowed the design team to have a good understanding of exactly what features would help the end users to do their jobs more efficiently. As such, the very first meeting was important for both parties to establish expectations and restrictions.

In an effort to successfully establish communication between all parties, our group went to the first meeting with a preliminary design proposal in hand. Our proposed design was based off of research we conducted on past implementations (see section 2.3) and featured outputs that we viewed as useful. It was important for us to also consider the needs of the sponsors in providing the Venetian government with an authoritative resource for environmentally conscious decision making.



The illustration in Figure 15 represents the entire process of determining end user requirements graphically. As you can see from the

Figure 15: Determining End User Requirements

figure, the proposal, interview, and revise process were repeated until the design team felt that we had sufficient understanding of the end user requirements of the sponsors. When this occurred, the group formalized a set of end user requirements which were then directly applied to the next step of the procedure.

It should also be noted that the cycle did not necessarily end after user requirements had been made. Instead, the proposal, interview, and revise cycle continued throughout the duration of the project. After the initial set of end user requirements was settled on, it only meant that the design team could move forward in the methodology. After a prototype system was developed, it was important to return to the sponsors (end users) with the new proposal and we received their feedback again.

3.1.2 Determining Design Specifications

After agreeing upon a set of end user requirements, the design team then focused their efforts on creating the set of design specifications. These specifications were exhaustive and complete, as they served as the mold that the group used during the programming and implementation phase. The design was shaped by the feedback given to the group following proposals and demonstrations, and also by innovative features learned from our background research on past implementations.

3.1.3 Implementing the Design

The design specifications that were created gave way to our implementation plan. Through the use of various technologies and software, work was done on the new dynamic atlas, called *Atlante dinamico*. The site as a whole was built using HyperText Markup Language (HTML) and utilizes other languages, such as Hypertext Preprocessor (PHP) and JavaScript, to provide more advanced features. In order to display the maps online, pMapper 2.0 was provided by the *Osservatorio*. Their current *AtlanteWeb* utilizes a highly modified previous version of pMapper to display their information. Tom was the sole programmer of the aforementioned pieces of *Atlante Dinamico*, and used translations of the *Atlante* text by Josh and Leia to provide content for the English site. He collaborated with Chris Vitone at CityLab to create a data entry form that would allow for real-time updates. CityLab was provided with a near-complete form for data-entry and went through to ensure it linked properly to a database, as well as implemented key features like the clickable map for easy location reporting.

3.2 Testing the Functionality of the System

The last step of the waterfall model brings us to our second objective: testing. After we received a prototype from City Lab, it was tested to ensure its functionality and ease of use. Testing consisted of two main phases, each testing the two separate interfaces that our system utilizes. The first phase tested the functionality of the data entry form and the database. The second phase tested the external user interface. That is, the system that displayed the dynamic maps to the patrons of the *Osservatorio* and *Museo*.

3.2.1 Testing the Data Entry Form

Before any analyses or conclusions could produced using our new system, all of the past census data was inputted. The easiest way to do this was to simply insert the data tables into the backend of the system. This was how we populated the majority of our data into the system. However, the group manually input some of the data using the online data entry form, to essentially test our system from start to finish. Testing the form in this manner also introduced the group to certain nuances of the data entry form that could help to improve the interface before it was introduced to the sponsors. As such, the group planned to manually enter the most recent dataset into the database and to import the rest of the tables so that we could continue on with the testing phase.

3.2.2 Testing the Online Atlas

After we entered some census data using the two methods described above, we then moved on to test the external interface that will eventually be used by any *Osservatorio* and *Museo* patrons that have access to the internet. Most of this was completed by simply testing every possible aspect of the interface to identify and fix bugs. The design team also allowed outside sources to use the system and point out any interface discrepancies or other functionality issues.

3.3 Demonstrating the Usefulness of the System

In the end, the purpose of developing a dynamic bird atlas from start to finish was to demonstrate to the *Osservatorio* how a complete dynamic atlas would help them to do their job more accurately and effectively. The birds section of the atlas lent itself to being the prototype for the dynamic atlas because the data is constantly changing and is already being collected on a regular basis by a certified group of experts. To properly execute this objective, the design team

demonstrated our prototype system to the *Osservatorio* in a way that encouraged thought and reflection on exactly how a dynamic atlas could be properly deployed so as to bring the most benefit to the environment of the lagoon.

3.4 Determining Other Data Sets to Update

Our work on the bird data in the atlas served as a test case for what was possible for a dynamically updated atlas. To further emphasize the usefulness of the system, we needed to identify other areas of the Atlas that lent themselves to being cataloged dynamically. For example, some sections of the Atlas record facets of the environment that do not change often enough to make implementing a dynamic system worthwhile. However, other sections of the Atlas are similar to the birds section in that changes can be noted on a regular basis, such as annually or even seasonally. We targeted these sections as ones that would benefit from the implementation of a dynamic Atlas.

Our goal was to produce a prioritized list of data sets in the atlas that would most benefit from a dynamic atlas medium. There were three factors that went into creating this list:

3.4.1 How Often Does the Data Change?

This is the first and most important indicator of a data set that lent itself to dynamic updates. Some types of data recorded in the Atlas simply do not change enough to make a dynamic system worthwhile. For example, the majority of the maps found in the Geosphere section record data that only changes at a minimum every ten years. Some of the data contained in this section takes well over 100 years to notice a change. It is these types of data that were marked not important to implement in a dynamic form.

3.4.2 How Often is the Data Collected?

This was another very important factor because some data sets in the atlas are in fact constantly changing, but for a variety of reasons (mostly financial); the changes are not recorded on a regular basis. However, some changing data sets are recorded on a regular basis already, and these are the data sets that we targeted for early adaptation to the dynamic atlas medium.

3.4.3 Who Collects the Data?

The final factor we took into account while compiling our prioritized list was which organizations were responsible for collecting the data. This was important because these agencies

will eventually have to be convinced of the benefits of a dynamic atlas. These organizations will have to adopt the idea of collecting their data on a regular basis and entering it into the dynamic atlas database.

4 RESULTS AND ANALYSIS

All of the deliverable results of our project can be accessed through the group's home page. The project web page also serves as an excellent descriptor of the work that went on, as it guides the user through each and every aspect of our project in a chronological manner. The user is guided through the three stages of the *Atlante della laguna* that this project encompassed and can click on examples of each of these three types. In addition, one can also access all of the team's documents, data, and presentations from this page. The webpage can be viewed at http://users.wpi.edu/~tomp/IQP and is depicted in Figure 16.

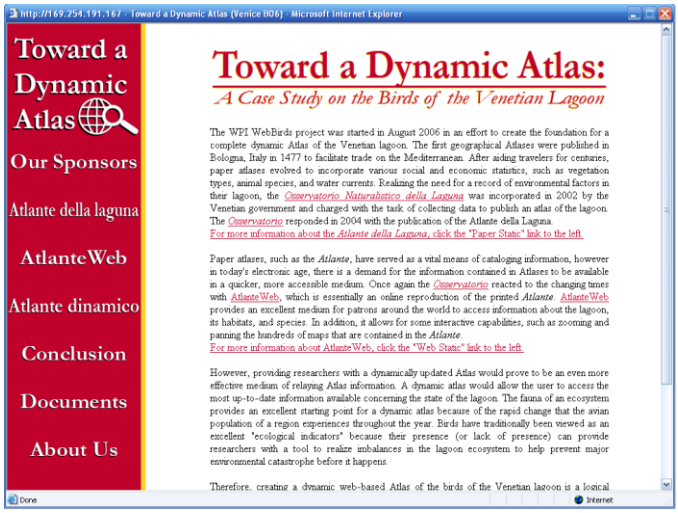


Figure 16: Project Web Page

4.1 System for Dynamically Managing Bird Census Data

The primary deliverable from this project was the *Atlante dinamico* website and all the information contained therein. After obtaining the user requirements from the sponsors, the project team put together a proposal for the site, combining the desired output from the *Osservatorio* and functions we thought the system should have. From there the team began to implement these parts of the atlas, piece by piece, until the final product was obtained and able to be accessed.

4.1.1 End User Requirements

Subsequent to our first meeting with representatives from the *Osservatorio, Museo di Storia Naturale,* and *Associazone Faunisti Veneti*, the team brought away several key functions that were needed for the dynamic atlas. Primarily, they requested the ability to update data as it became available, as current data is important in an ever-changing world. The second major concern was making the web atlas bilingual. Behind these new developments the functionality and content of *AtlanteWeb* should be maintained, as it is a useful tool in and of itself.

4.1.2 Design Specifications

After our first meeting with the primary sponsors of the project, we felt that we had a good grasp on their expectations. In other words, we had a final set of end user requirements. According to our methodology, we combined what the sponsors wanted with what we learned during our background research phase and came up with a set of comprehensive design specifications. The full design specifications can be seen in Appendix 8.3.

4.1.3 Implementation

The implementation phase of the project was undoubtedly the most time consuming and involved of all the phases. Throughout the implementation, several aspects of our project had to come together as one. First, the skeleton for the site was designed and coded. While this was going on, other group members were busy translating all of the Italian text from the *Atlante* in the birds section into English. After rough translations were done, the translated text was sent to Daniela Pavan at the Venice Project Center to be proofread and verified. In addition, species distribution maps and a species catalog were compiled. The results of the implementation phase are described below.

4.1.3.1 Atlante dinamico

The first page that is displayed when *Atlante dinamico* loads is pictured in Figure 17. From this page, the user selects which language is preferred. There is also an option for the user to change the displayed language once in the *Atlante*. The site can be reached through our main project webpage at http://users.wpi.edu/~tomp/IQP, by clicking the *Atlante dinamico* link on the left menu.

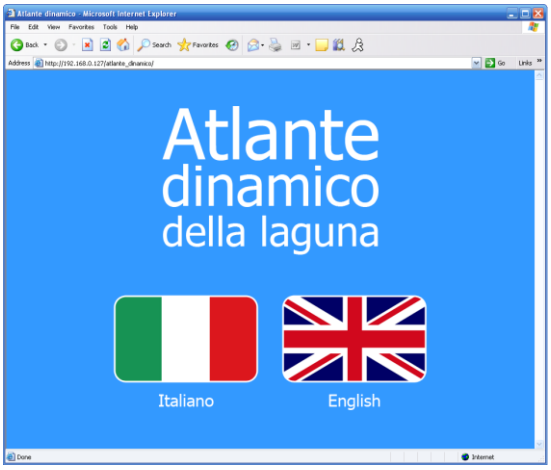


Figure 17: Main Page

The website has a different template, thus giving the atlas an improved interface and a fresh look and feel. It still contains all of the previous functionality of *AtlanteWeb*, displaying all the same maps and text. After selecting a language, the user is brought to the introduction and welcome page, as seen in Figure 18. The text for the introduction page is the exact same as the text from *AtlanteWeb*. From this page, the user may then choose one of the five sections of the *Atlante* to explore: Geosphere, Biosphere, Anthroposphere, Protected Areas, and Integrated Analysis. These five sections are represented by the colored semi-circles at the top of the page.

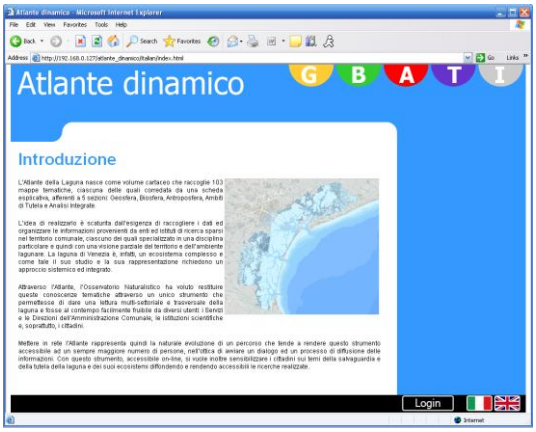


Figure 18: Introduction Page

Since our project focused on the birds' part of the biosphere section, that part of *Atlante dinamico* is developed much more than the others. However, the framework is there for continued work to be done on the rest of the *Atlante dinamico*. By selecting one of the map titles in the toolbar on the right, users can view the text of the selected table in the language chosen. An example of a text page from the birds section is shown in Figure 19.

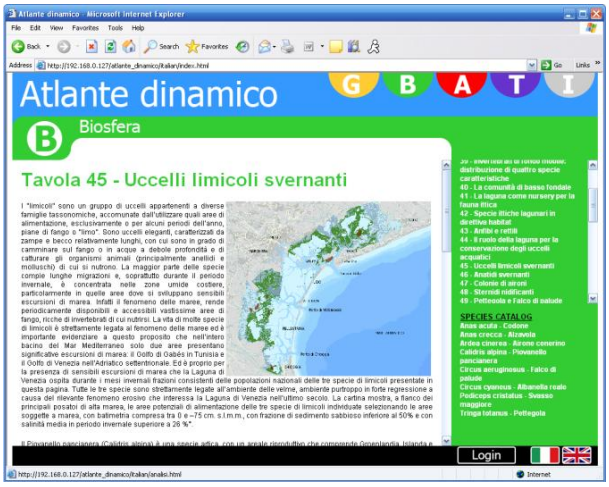


Figure 19: Birds Text Example

Below the map names, there is another toolbar for the dynamic species catalog. This species catalog has an entry for every single bird that is expected to be seen in the lagoon from year to year. Each link will present a page on the selected species. Each species' catalog page contains specific information such as habitat, food sources, and identification tips. Figure 20 shows the species catalog page for the *Alzavola* duck.

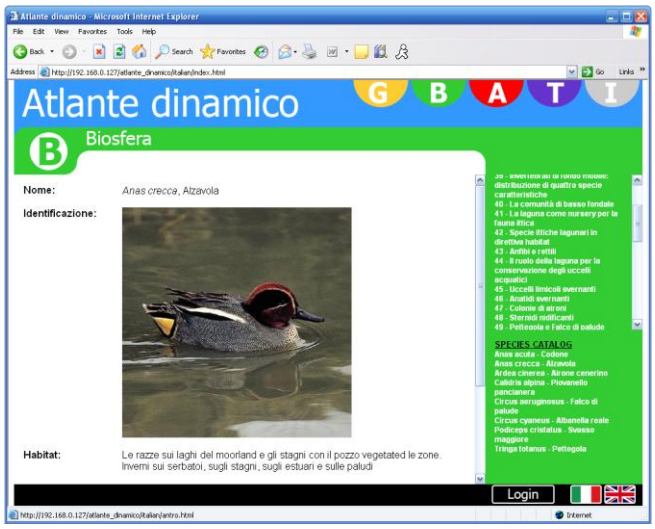


Figure 20: Species Catalog, *Alzavola* Duck

In addition to finding information on the species, it is also possible to view their distribution on an overlay of the lagoon. The distribution throughout the lagoon is a truly dynamic feature of the atlas, as it shows changes to the bird population immediately as new data becomes available. Using the pMapper interface, the user can select one or more species on the list to view, as well as any of the layers from the maps that are currently available on *AtlanteWeb*. Using this interface, one can view data and perform analyses with the simple click of a mouse.

The backbone of *Atlante dinamico* is the pMapper interface. Anytime the user clicks on a link that requires the display of an interactive map, a new window is opened and pMapper is started. This web applet allows the user to select a variety of layers of GIS maps to view in the same window. The advantage to using this system is that the user defines any combination of available layers to view. No special GIS or MapInfo skills are required, yet it allows to user to perform multivariate analyses on any of the data layers that are made available to them. For our instance of pMapper, all of the maps from the *Atlante* are available in addition to the past ten years of species distribution maps. A screenshot of the pMapper interface displaying the distribution of the *Alzavola* duck in 2006 is shown in Figure 21.

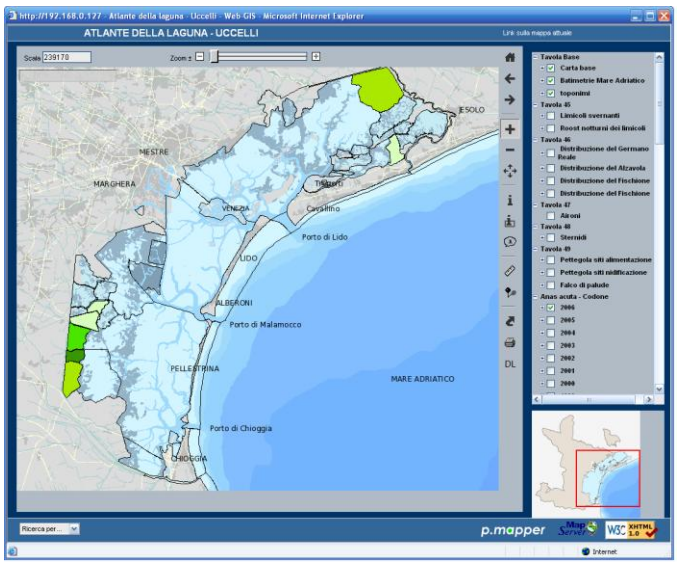


Figure 21: pMapper web-GIS Interface

4.1.3.2 Online Data Entry Form

While most of the work on *Alante dinamico* was handled internally by the group, the coding for the online data entry form was handled by CityLab after we submitted the design specifications to them. Any user with the proper login credentials can access the data entry form by clicking on the "Login" button seen at the bottom of any page in the *Atlante dinamico*. After clicking the "Login" button, the user is taken to a page with a list of all the organizations contributing to *Atlante dinamico*. As mentioned before, our project focused primarily on the birds section, so only the link for *Associazone Faunisti Veneti* works on this page. Clicking on the *Associazone* logo brings you to the online data entry form, shown in the middle of Figure 22.

The flow of data from the field into the is depicted in Figure 22 below. First, the data is collected in the field using the existing *Associazone* field form. That data is then put into the online entry form. When the online form is submitted, it is sent to the pMapper database. It is this database that *Atlante dinamico* will use to display the most up to date information available.

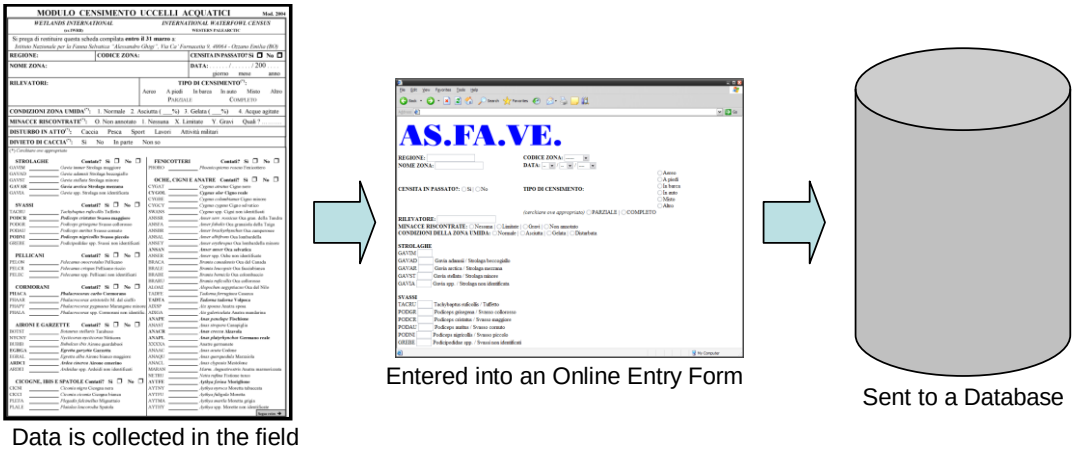


Figure 22: Flow of Data

4.2 Functionality Test Results

For this project, testing consisted of two stages, testing the internal and external portals. First, the internal portal was tested because the data entered during this phase of testing is used by the external portal during the second phase of testing.

4.2.1 Data Entry Form Test Results

In order to test the online entry form, the group entered a few sets of data to ensure that it was accurately stored in the database upon submission. The database showed that the test was successful and reflected what was submitted through the entry form. The next test was to see if the search function operated correctly. This tool allows users to click on one of the 44 areas of the lagoon to bring up the records of that area. The search function accurately displayed the information on who submitted the data, if they had completed a census before, and other questions pertaining to the census process. However, there seemed to be a bug in the display of the counts themselves, as there was occasionally some missing bird species. An attempt was made at resubmitting the data or updating it with a different count or other species, but that resulted in the previous missing species appearing and some of the new ones not being displayed. While it was unfortunate that this bug was present, the group recognized that this feature was added as an afterthought and did not prove to be a major obstacle. The group provided CityLab with a report on this bug; as of the time of writing this report, it remains unresolved. Upon completion of the first testing phase, it was necessary to move on to testing *Atlante dinamico*.

4.2.2 Atlante dinamico Test Results

Atlante dinamico was constantly tested throughout its development. Since the final product had so many interlocking elements, it was crucial that all the links to text, images, maps, and other pages worked correctly. It was also very important to make sure that the information corresponded to the correct tables in the original atlas. Any problems encountered were fixed on the spot and retested. In addition, this process was repeated on several different occasions and under several conditions (various computers, resolution sizes, etc.). One more crucial element to *Atlante dinamico* that had to be reviewed extensively was the Italian to English translations.

Throughout the development of *Atlante dinamico*, we ran into several technical problems with the system that will have to be resolved before continuing. For example, one problem that occurred during development was with the pMapper software. The difficulty was that the system has a set number of map layers that can be displayed at once. In the course of adding the species distribution data to our system, we exceeded the limit. The problem was temporarily resolved by removing maps that were not being used in our project (i.e. maps in the other sections of the atlas). The *Osservatorio* will have to find a way around this if they plan to make the atlas complete with all of their maps.

Another technical difficulty we discovered involved the information button on the toolbar. This button displays data about an item when something on the map is clicked. Selecting single items by this method worked fine, but when a group of objects was selected, no information was displayed. Again, this is an ongoing problem that the *Osservatorio* is aware of and will be worked on in the future.

The last major problem is mostly one dealing with the aesthetics of the application. The various checkboxes to the right of the map are all expanded when it starts. This makes the list quite a bit longer, and makes it significantly harder to navigate. In the future, a way to collapse all these lists should be devised to make it easier to use. In addition, it would also be desirable to have the legend of the displayed map default to the expanded state.

4.3 Demonstrated the Usefulness of the System

On Wednesday December 6, 2006 the design team made a presentation to representatives of the *Osservatorio, Museo,* and *Associazone*. The purpose of the presentation was to demonstrate the work that we completed on the dynamic atlas. The presentation consisted of brief background information, a demonstration of *Atlante dinamico*, and suggestions on what steps to take to implement a complete dynamic atlas. The sponsors were impressed with our work and had a great deal of insight to offer, especially regarding our work on the fourth objective. In the end, the sponsors felt that our system would be most useful as a means of collaborating up to date data from multiple sources. Essentially, this could be an advantage of *Atlante dinamico* for participating organizations; that they could access similarly up to date data from other organizations and use it to perform their own research and analyses.

One of the best ways to demonstrate the usefulness of our system is to present an analysis that could be done with our system that could not be performed with the existing *AtlanteWeb* software. One of the biggest advantages to *Atlante dinamico* is that it automatically generates maps that can be used for subsequent analyses by researchers (this will be discussed further in Section 5.4). Some of these maps are very complex in nature, and would normally take a skilled GIS technician several hours to produce. *Atlante della laguna*'s Table 45, which tracks the potential foraging areas of wintering waders in the lagoon, is an example of one of these complex, multivariate maps. The map, shown at the top of Figure 23, is compiled from three other data sets: water salinity, sediment grain size, and bathymetry (water depth). The following criteria represent the potential foraging areas for wintering waders in the lagoon:

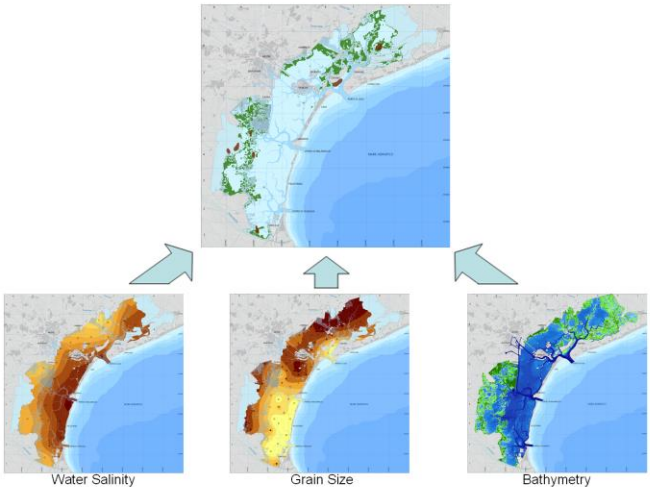


Figure 23: Table 45 and Contributing Data Sets

- salinity is less then 25%
- the grain size is less than 50µm
- water depth is greater than 75cm

In order to identify the areas of the lagoon that satisfy these requirements, a user must perform several operations in MapInfo or a similar GIS software package. However, *Atlante dinamico* automatically compiles this map which makes it much easier for researchers to alter the parameters and predict what would happen to the habitat of wintering waders if a certain aspect of the lagoon was changed, such as the construction of MOSE.

4.4 Other Data Sets to Update

This conclusive objective recommends to our sponsors what the next course of action should be for moving toward a complete dynamic atlas of the lagoon. The criteria for the data sets that the group targeted as priority are described in Section 3.4. After scrutinizing each individual

data set in the atlas according the criteria we established earlier, the group compiled a spreadsheet assigning a progressive rating to each data set. Each data set was assigned a one, two, or three rating according to the following key: (1) data that does not need to be updated dynamically, (2) data sets that should be updated every 5-10 years, and (3) data that should be updated as often as possible. The data sets categorized as a (3) are ones that the group has identified as the data sets that lend themselves to dynamic data entry. After sharing our findings with the *Osservatorio*, our liaison Stefano Guerzoni, offered to revise our list based on his knowledge of the atlas and the information contained therein.

Each map has an entry in the spreadsheet with the its name, the priority rating, and the organization that is responsible for collecting the data. In some cases, more than one organization contributes data for one map. The format of the spreadsheet is shown in Figure 24. The full

Title	Category	Organization
Average Annual Temperature	2	CNR - ISMAR Venezia, ARPAV, Magistrato all Acque di Venezia (MAV)
Average Seasonal Temperature	2	CNR - ISMAR Venezia, ARPAV, MAV
Mean Frequency Values of Principal Eight Directions (Wind)	2	CNR - ISMAR Venezia, ARPAV, MAV
Tide Level Measurement Stations	3	Comune di Venezia Istituzione Centro Previsione e Segnalazione Maree
Speed Limits	1	Comune di Venezia Istituzione Centro Previsione e Segnalazione Maree
Depth Range	2	Magistrato alle Acque di Venezia attraverso il suo concessionario Consorzio Venezia Nuova
Difference of Depth / Depth Range	1	Magistrato alle Acque di Venezia attraverso il suo concessionario Consorzio Venezia Nuova
Shepard's Sediment Classification	2	Dipartimento do Scienze Ambientali - Università Ca' Foscari di Venezia (DSA - UniVE), CNR - ISMAR Venezia, MAV
Grain-size Distribution	1	MAV
Dolomite and Silicates in Sediments	1	DSA - UniVE, CORILA - Subproject 3.2 Hydrodynamics and Morphology, Technical Report 2004
Organic Carbon in Sediments	1	MAV, Valutazione integratadello state qualitativo attuale dei sedimenti lagunari superficiali
Origin of Substrates	1	Comune di Venezia, TU Berlin
Soil Classifications According to WRB	1	Comune di Venezia, TU Berlin
Detailed Soil Classification (WRB-enlarged)	1	Comune di Venezia, TU Berlin

Figure 24: Spreadsheet Format

spreadsheet can be seen in Appendix 8.3.

Of the 103 maps in the *Atlante della laguna*, 30 are found to be of category one, 45 of category two, and 28 of category three. As mentioned previously, the category three maps are those that will be recommended to the sponsors as most feasible for a dynamic atlas medium. Additionally, these 28 category three maps can be prioritized further according to the organization that collects the data. For example, the *Magistrato alle Acque di Venezia* provides the data for 12 of the category three maps, and therefore should be first persuaded of the dynamic atlas concept. In total, there are 14 organizations that keep the data for category three maps. These organizations must be convinced of the dynamic atlas concept, and also must adopt regular data collection and online entry of that data.

5 RECOMMENDATIONS

Upon conclusion of this project, the *Osservatorio* has a much better idea of the specifics involved in the creation of a complete dynamic atlas. Although significant advancements have been made through the efforts of our group, a great deal of time and effort are still required in order to see the true benefits of our research. This chapter will give a prioritized outline of the subsequent steps that should be taken by the *Osservatorio* toward a full implementation of a dynamic atlas.

5.1 Full Implementation of Bilingual AtlanteWeb

The full implementation of a bilingual *AtlanteWeb* is a very beneficial first step for the *Osservatorio* as it would quickly and relatively easily increase the audience for their existing *AtlanteWeb* system. With this increased audience, it gives the *Osservatorio* even more leverage for the creation of a dynamic version of the *Atlante*.

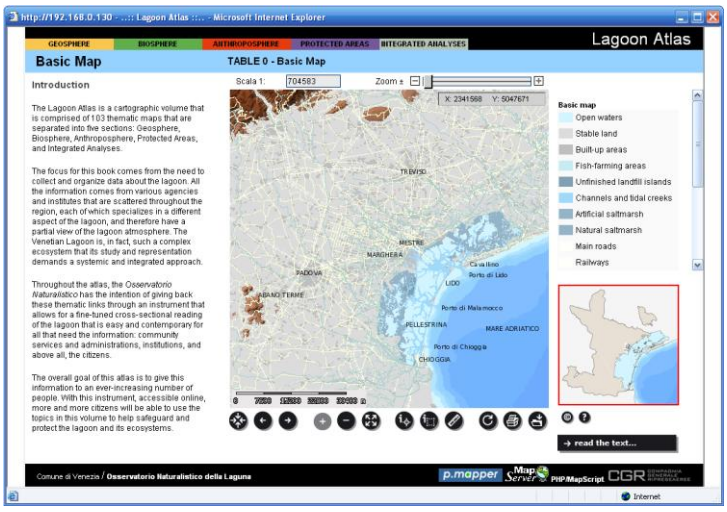


Figure 25: AtlanteWeb English

As part of our work on this project, our team has already translated the nine sections of the atlas concerning the birds of the lagoon. The process of translating, although time consuming, is a straightforward procedure. This process could even be contracted out to a third party for a nominal fee. Our group has translated a majority of the framework of *AtlanteWeb*, shown in Figure 25, meaning that the remaining Atlas text is all that is left to complete. Ultimately, translating the remainder of the *Atlante* would have long term benefits far outweighing any costs.

5.2 Continue Development of Dynamically Updated Maps

This recommendation represents perhaps the largest hurdle towards a complete dynamic atlas. This was the only facet of a dynamic atlas that our project did not address, due mostly to time constraints. This topic represents the gap between our online data entry form and the pMapper

interface of *Atlante dinamico*. The online data entry form that the group developed saves data to a database that could eventually be recalled by pMapper to display the most up-to-date information available. This process will happen on the fly so that whenever any user logs on to *Atlante dinamico* they will only see the updated data.

This is a one time task that represents the most innovative feature of *Atlante dinamico*. Once developed, it will allow for the automated creation of updated maps. The benefits of this are countless. Primarily, it would allow for small organizations with little or no knowledge of GIS mapping systems to create complex maps for analyzing their own proprietary data. This concept will be discussed more in Section 5.4.

5.3 Full Implementation of a Dynamic Bird Section

As soon as the technical backbone of a dynamic atlas is in place, the first part of the Atlas that should be converted is the birds section. The reasons why the birds section would be an excellent candidate for a dynamic atlas are outlined in Section 2.1. Before a dynamic atlas can be implemented throughout the *Atlante*, it is preferable to work out as many of the glitches as possible by means of a thorough implementation of one section of the atlas. This will allow the *Osservatorio* to have a good amount of experience when dealing with the subsequent organizations and trying to change their procedures to better accommodate dynamic data entry. In other words, they will posses a model to present to potential contributors.

Through our project work, we have already developed a preliminary working relationship with the *Associazone Faunisti Veneti*, and have determined that they would in fact be willing to make the change to a dynamic style of data entry. For their particular organization, the change would only require one extra step in their data collection process. The fact that only one additional step is required to realize all the benefits of a dynamic atlas makes it even easier for them to decide to participate in the program.

5.4 Convince Top Contributors of Advantages

The next step for the *Osservatorio* is to contact other frequently updated data providers and convince them of the benefits of a dynamic atlas, using the birds section as an example. The organizations that should be contacted first are listed in the spreadsheet in Appendix 8.3, and were selected according to the criteria outlined in Section 3.4. The first organization that should be contacted is the *Magistrato alle Acque di Venezia*, who supplies data for twelve of the category three

maps, as well as several category two maps. The list below gives the top four category three contributors and the number of data sets that they provide to the *Atlante*.

- Magistrato alle Acque di Venezia – 12
- Università di Venezia - 7
- ISMAR - 5
- Comune di Venezia – 4

Convincing the fourteen organizations providing data for category three maps of the benefits of dynamic atlas will be no easy task and the *Osservatorio* should approach the proposal prepared to sell the concept of *Atlante Dinamico*. The next three sections outline three very important selling points that can be used to convince contributing organizations of the dynamic atlas concept. Three very important benefits for the *Osservatorio* to utilize when convincing contributing organizations of the usefulness of the atlas are outlined below:

5.4.1 Automatically Generated Maps for Analysis

Perhaps the greatest benefit of *Atlante dinamico* is that it would provide small organizations with a preset template for creating GIS maps to visually display their data. These organizations would simply input raw data into the system, and a visualization of that data would be automatically generated. Oftentimes, visualizations of data are far more useful for performing analyses than just looking at numbers.

5.4.2 Medium to Present Research to a Larger Audience

As with all projects that are put onto the internet, the atlas will now have a much larger audience. Spreading awareness of the environment is the first step in helping to preserve the home of the wildlife and the humans in Venice alike.

5.4.3 Data Storage Alternative

Storage for information is important in the digital age, and so this system would offer another alternative for saving the data of the organization in question. They would also benefit from an added layer of security, should their primary storage system fail.

6 CONCLUSION

The greatest advantage for the *Osservatorio* to implement the *Atlante dinamico* is that it would help them to do their job more efficiently and effectively. That is, it would allow them to make more accurate evaluations on the state of the Venetian lagoon, and therefore provide the city of Venice with even more precise recommendations regarding urban development and the environment. Possessing a computerized representation of the exact state of the lagoon environment is a very powerful tool whose uses are almost boundless. This is not to mention that this representation would be made available to any computer user worldwide.

Although at first it would appear as if the *Osservatorio* and its patrons would be the only beneficiaries of a dynamic atlas, in reality all of the organizations that contribute data to the *Atlante* would gain the same benefits from the full implementation of *Atlante dinamico*. Participating organizations would enjoy the rewards of the automatically generated maps for analysis, a larger audience, and a data storage alternative. The fact that so many agencies and their patrons would benefit should in itself be reason enough to push the *Atlante dinamico* project forward and gain initial funding and support.

Overall, the *Atlante dinamico* would represent a major innovation in the evolution of the *Atlante della laguna*. This would allow for the possibility of many ancillary benefits to the *Osservatorio* and its associates, such as opportunities for professional recognition and awards for their work on the *Atlante dinamico*. This publicity would also have a positive effect on the *Atlante* itself, bringing even more users to the site to explore the features and advantages of a full dynamic atlas.

However, it is important not to undervalue the primary beneficiary of our work: the environment of the Venetian lagoon. The implementation of a dynamic atlas would help the *Osservatorio* to better determine which urban development projects would have a significantly adverse effect on the Venetian environment and assist in formulating future plans to maintain the natural state of the lagoon. On the other hand, being able to better gauge the current state of the lagoon may give the *Osservatorio* more authority to approve other improvement projects to take place, thus benefiting the city of Venice and its citizens.

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8 APPENDICES

8.1 Annotated Bibliography

8.1.1 Past Implementations

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Our topic is almost directly related to this article in which it describes the use of developing technology, such as web-based GIS, being used to modernize the public health management system in Greece and other parts of Europe. The system being developed supports various health-related web applications including early warning and response of epidemics, remote management of medical records, as well as many others.

Conrad, E. R. "Developing Digital Neural Networks for Worldwide Disease Tracking and Prevention." Computer Science and Telecommunications Board of the National Research Council, Workshop on Spatial Databases, National Academies, Washington, DC, October (2001): 1–2.
<http://www7.nationalacademies.org/cstb/wp_geo_conrad.pdf>

This article is a review of a GIS system implemented after the West Nile Virus breakouts in New York City in 1999. The project was managed by the Pennsylvania Department of Agriculture and ESRI was contracted to design the GIS database. The system was dynamic and accessible online to all the various agencies that would need it (state, local, national). There is mention in the article that their system could be easily applied to track the spread of avian influenza and other animal carried diseases.

Hadidian, J., et al. "A Citywide Breeding Bird Survey for Washington, DC." Urban Ecosystems 1.2 (1997): 87-102.

This article is a summary of "Project Birdscape" which took place in Washington DC starting in 1993. The purpose of their research was to determine if different types of urban land use (residential, industrial, etc.) effected the species of birds that were present in the area. There is some useful information here regarding the specifics of taking the census and recording the data.

Emlen, J. T. "An Urban Bird Community in Tucson, Arizona: Derivation, Structure, Regulation." The Condor 76.2 (1974): 184-97.

This is a more generic article about a typical breakdown one would expect to see from an urban bird population. The article goes into great depth comparing what happens to a bird population after urbanization. It is useful to our project because it gives some insight as to what aspects of a bird population are good indicators of overall ecologic health.

Kraak, M. J. "The Role of the Map in a Web-GIS Environment." Journal of Geographical Systems 6.2 (2004).

This article discusses the expanding roles of maps in a Web-GIS environment for displaying both geographic and non-geographic information on the internet. This directly relates to the system we are going to design and will give us a greater understanding of the materials we'll be working with.

8.1.2 GIS

Edler, Alice A. 2006/2. Avian flu (H5N1): Its epidemiology, prevention, and implications for anesthesiology. Journal of Clinical Anesthesia 18, (1): 1-4.

This journal entry provided many basic fatcs and factiods in regards to avian influenza, its epidemiology and prevention, all very useful in background and analysis.

Zockler, Christopher. "Migratory bird species as indicators for the state of the environment." Biodiversity, Nov 2005 7-13.

This article identifies all the basics needed for bird tracking, mentions environmental factors that affect birds, and discusses a web-GIS tracking system. Holy Grail item.

"Avian Influenza Infection in Humans." Center for Disease Control and Prevention, Aug 9 2006. 10 Sept 2006. < http://www.cdc.gov/flu/avian/gen-info/avian-flu-humans.htm.>

This website is a reliable source for the most up to date and detailed information regarding Avian flu, including most recent outbreaks and their locations in humans and animals.

8.1.3 Birds and Avian Flu

Roppola, A. J., and A. L. Bugg. "Innovative and Effective Internet Information Systems for Natural Resource Managers: Geographic Visualization." Journal of spatial science 49.1 (2004): 49-60.

Roppola and Bugg discuss the use of geographic information systems as a way to manage natural resources dynamically. This can be applied to bird tracking, and also as a foundation for future items to be tracked by the atlas.

Clarke, K. C., S. L. McLafferty, and B. J. Tempalski. "On Epidemiology and Geographic Information Systems: A Review and Discussion of Future Directions." Emerging infectious diseases (Print) 2.2 (1996): 85-92.

This article investigates the uses of geographic information systems in the field of epidemiology. It explains how even in minimal use, they help provide a spatial perspective on disease. When used to its optimum capacity, GIS is seen as a valuable tool for analysis and decision making.

"Avian Flu." Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333, USA. Accessed September 23, 2006. <http://www.cdc.gov/flu/avian/.>

This is the dictionary for Avian Flu. As an extremely reliable resource, it not only has plenty of information in its own right, but provides links to many other reliable sources, including photos and statistics.

Lovgren, Stephen. "Bird Flu Basics:What It Is and How It Could Explode." National Geographic News. Accessed September 25, 2006. <http://news.nationalgeographic.com /news/2005/11/1123_051123_bird_flu.html>

This is another extremely reliable source for information on Avian Flu, also has many links to other pages. Is very up to date and informative, with many statistics and realistic world views.

"A Global Strategy for the Progressive Control of Highly Pathogenic Avian Influenza (HPAI)." FAO, OIE, WHO, Rome, Paris, Geneva, November 2005. Accessed September 24, 2006. <http://www.fao.org/ag/againfo/subjects/documents/ai/HPAIGlobalStrategy31Oct05.pdf>

This PDF file is an excellent resource for strategies on how to deal with Avian Flu on a global scale and what should be done in terms of smaller regions tracking migratory birds and educating the public about the disease.

8.1.4 Venice and the Lagoon

Sutherland, William. Ecological census techniques: a handbook. New York, Cambridge University Press 1996.

This book is a good foundation to start from- it is about the basics of taking ecological census' and the various techniques used.

Ravera, O. "The Lagoon of Venice: The Result of both Natural Factors and Human Influence." J.Limnol 59.1 (2000): 19-30.

This journal article has general information on the state of the lagoon and what things in the world affect it.

Place Knowledge,
http://www.wpi.edu/Academics/Depts/IGSD/Projects/Venice/Center/Projects/IQP_public/E05/Lagoon/Word/

This IQP project on place knowledge in the lagoon will be useful for the background chapter about the lagoon. It also contains references to further sources on the lagoon and GIS mapping

8.2 Design Specifications

Proposal for *Atlante Dinamico*

The new website will contain two portals: an innovative "internal portal" for entering annual wintering bird census data, and an "external portal" for patrons of the *Osservatorio* and *Museo*.

Internal Portal

- To be used by the *Museo di Storia Naturale* and the *Associazone Faunisti Veneti* to enter wintering bird census
    - System can be implemented immediately for use every January (frequency of census currently) but could easily be adapted for more frequent/accurate data collection
- Features
    - Census Entry
        - Interactive Map: Used for selection of the location that the data was collected at. The entry form and map will use the *existing* location codes and map
        - Form
            - Location code will auto-populate according to location selected on the map
            - "recommended" or "expected" bird species will also auto-populate, with just the number of birds recorded being required (zeroes are OK)
                - This recommended list will be made from the past 10 years of data that we have received
                - Blank species code fields will also be available for unexpected sightings
            - On a separate frame in the same window (or similar layout), you will be able to click on a bird species and an "ID Tips" page will appear
                - "ID Tips" will be in a separate window and will be species specific with pictures, habitat information, breeding schedule, eating habits, etc. – anything helpful for the birdwatchers
            - Submitting the form will send the data directly to the Access database, which can later be accessed by MapInfo to create up-to-date maps
- Other Options for Future Development
    - Pre-Census Package
        - Click on the location that you expect to census, and expected species "ID Tips" links, general information on bird watching, detailed map of the census area, etc. will show up

External Portal

- Section for *Osservatorio* and *Museo* patrons
- Essentially an online, English version of the birds section of the Atlante
- Added Features
    - Access to species "ID Tips" from internal portal
    - Additional in text links to relevant information (definitions, RAMSAR webpage, etc.)
    - Dynamic maps populated from the Access database

8.3 Objective Four Data Set Spreadsheet

Tavola	Title	Category	Organization
1	Average Annual Temperature	3	CNR - ISMAR Venezia, ARPAV, Magistrato alle Acque di Venezia (MAV)
2	Average Seasonal Temperature	3	CNR - ISMAR Venezia, ARPAV, MAV
3	Mean Frequency Values of Principal Eight Directions (Wind)	3	CNR - ISMAR Venezia, ARPAV, MAV
4	Tide Level Measurement Stations	3	Comune di Venezia Istituzione Centro Previsione e Segnalazione Maree
5	Speed Limits	1	Comune di Venezia Istituzione Centro Previsione e Segnalazione Maree
6	Depth Range	2	Magistrato alle Acque di Venezia attraverso il suo concessionario Consorzio Venezia Nuova
7	Difference of Depth / Depth Range	1	Magistrato alle Acque di Venezia attraverso il suo concessionario Consorzio Venezia Nuova
8	Shepard's Sediment Classification	2	Dipartimento do Scienze Ambientali - Università Ca' Foscari di Venezia (DSA - UniVE), CNR - ISMAR Venezia, MAV
9	Grain-size Distribution	2	MAV
10	Dolomite and Silicates in Sediments	1	DSA - UniVE, CORILA - Subproject 3.2 Hydrodynamics and Morphology, Technical Report 2004
11	Organic Carbon in Sediments	1	MAV, Valutazione integratadello state qualitativo attuale dei sedimenti lagunari superficiali
12	Origin of Substrates	1	Comune di Venezia, TU Berlin
13	Soil Classifications According to WRB	1	Comune di Venezia, TU Berlin
14	Detailed Soil Classification (WRB-enlarged)	1	Comune di Venezia, TU Berlin
15	Soil Systems	1	ARPAV - Osservatorio Regionale Suolo (ORS)
16	Alluvial Plain of Brenta River	1	ORS, ARPAV
17	Tidal Amplification	1	CNR, ISMAR Venezia
18	Residual Currents and Residence Time	1	CNR, ISMAR Venezia
19	Water Salinity (Average)	3	MAV
20	Water Salinity (By Season)	3	MAV
21	Reactive Phosphorus in Water Column (Average)	3	MAV
22	Reactive Phosphorus in Water Column (By Season)	3	MAV
23	Dissolved Inorganic Nitrogen in Water Column (Average)	3	MAV
24	Dissolved Inorganic Nitrogen in Water Column (By Season)	3	MAV
25	Chlorophyll A in Water Column (Average)	3	MAV
26	Chlorophyll A in Water Column (By Season)	3	MAV
27	Summer Concentration of Chlorophyll A	3	DSA - UniVE
28	Salinity	3	Regione del Veneto - ARPA Veneto, Osservatorio Alto Adriatico

29	Water Nitrate Concentration	3	Regione del Veneto - ARPA Veneto, Osservatorio Alto Adriatico
30	Sub-basin Surface	2	Progetto DRAIN, MAV
31	Mean Annual Water Discharge from Tributaries	2	MAV, Progetto DRAIN
32	Flood Event of November 7 1999	1	MAV, Progetto DRAIN
33	Groundwater Quality	2	Regione del Veneto, ARPAV
34	Nitrate Concentration	2	Regione del Veneto, ARPAV
35	Foraminifera Abundance	2	A. Albani (University NSW Australia), R. Serandrei Barbero (CNR - ISMAR Venezia)
36	Zooplankton Species Succession	3	CNR - ISMAR Venezia
37	Benthic Communities	2	MAV
38	Benthic Communities	2	MAV
39	Benthic Communities	2	MAV
40	Total Fish Abundance	2	CORILA, DSA - UniVE
41	Distribution of Fish Juveniles	3	CORILA, DSA - UniVE
42	Lagoon Species in Habitat Directive	2	CORILA, DSA - UniVE
43	Distribution of Genera Bufo and Podarcis	2	Museo di Storia Naturale di Venezia, MAV, Associazione Faunisti Veneti
44	Areas and Their Relative Ornithological Importance	1	Museo di Storia Naturale di Venezia, Associazione Faunisti Veneti
45	Wintering Waders	3	Provincia di Venezia - Assessorato alla Caccia e Pesca
46	Distribution of Wintering Ducks	3	Provincia di Venezia - Assessorato alla Caccia e Pesca
47	Heronries	2	Associazione Faunisti Veneti
48	Main Breeding Sites	1	MAV
49	Marsh Harrier	3	MAV, Associazione Faunisti Veneti
50	Yellow-Legged Gull Colonies in the Lagoon of Venice	2	DSA - UniVE, Provincia di Venezia - Assessorato alla Caccia e Pesca
51	Number of Pigeons	2	Comune di Venezia - Direzione Centrale Ambiente e Sicurezza del Territorio, Universita di Pisa - Dip. Ecologia Etologia Evoluzione
52	Yellow-Legged Gull Nests	2	DSA - UniVE, Direzione Centrale Ambiente e Sicurezza del Territorio
53	Distribution of Some Mice and Shrews	2	Museo di Storia Naturale di Venezia, MAV
54	Phytoplankton Species Succesion	3	CNR - ISMAR Venezia
55	Summer Concentration of Phytoplankton	3	DSA - UniVE
56	Macroalgae Distribution (2002)	2	MAV
57	Macroalgae (2002)	2	MAV
58	Macroalgal Biomass Distribution	2	DSA - UniVE
59	Macroalgal Biomass Distribution	2	DSA - UniVE
60	Seagrass Distribution	2	MAV
61	Seagrass Distribution	2	MAV
62	Seagrass Distribution	2	MAV
63	Distribution of Zostera Marina	2	DSA - UniVE
64	Vegetation Cartography	2	Comune di Venezia, MAV
65	Plant Communities	2	Osservatorio Naturalistico della Laguna - Comune di Venezia
66	Habitat Types	1	Osservatorio Naturalistico della Laguna - Comune di Venezia
67	Floristic-Vegetational Value	2	Osservatorio Naturalistico della Laguna - Comune di Venezia
68	Types of Vegetation	2	MAV

69	Pixel Classification	1	Istituto Veneto di Scienze, Lettere ed Arti
70	Classification of Sampling Stations	2	CNR - ISMAR Venezia, Provincia di Venezia, Comune di Venezia, MAV
71	Mean Deposition Flux	2	CNR - ISMAR Venezia, Provincia di Venezia, Comune di Venezia, MAV
72	Polluntant Load Delivered to the Venice Lagoon from Drainage Basin	2	MAV, Progetto DRAIN
73	Quality of Water Delivered to the Venice Lagoon from Drainage Basin	2	MAV, Progetto DRAIN
74	Sediment Concentration	2	MAV, Valutazione integratadello state qualitativo attuale dei sedimenti lagunari superficiali, Progetto ICSEL
75	Sediment Concentration	2	MAV, Valutazione integratadello state qualitativo attuale dei sedimenti lagunari superficiali, Progetto ICSEL
76	Concentrations in Water Column	3	Sezione Antinquinamento del Magistrato alle Acque di Venezia (SAMA)
77	Cadmium Concentration in the Sediment of the Canals	3	Comune di Venezia, Progetto Integrato Rii
78	Arsenic, Copper, Mercury, and Lead Concentrations in the Sediment of the Canals	3	Comune di Venezia, Progetto Integrato Rii
79	Zinc, PAH, PCB, and Organochlorine Concentrations in the Sediment of the Canals	3	Comune di Venezia, Progetto Integrato Rii
80	Land Use Classes	1	ARPAV
81	Erosion Along Saltmarsh Margins	2	MAV - CVN
82	Structure Use	2	MAV
83	Location of Sites of EC Interest	1	Regione Veneto, DGRV
84	Location of Special Protection Areas	1	Regione Veneto, DGRV
85	Important Bird and Bird Portection Areas	1	LIPU, BirdLife Italia
86	Maximum Speed Limits	2	MAV
87	Natural Biotopes	1	ARPAV - Area Ricerca e Informazione - Servizio Comunicazione ed Educazione Ambientale
88	Natural Biotopes	1	ARPAV - Area Ricerca e Informazione - Servizio Comunicazione ed Educazione Ambientale
89	Location of Cisternes	1	Comune di Venezia
90	Location of Cisternes	1	Comune di Venezia
91	Archive Function	1	Comune di Venezia, TU Berlin
92	Natural Areas with Primary Characteristics	1	Comune di Venezia Provincia di Venezia, MAV
93	Functional Ecosystem Assemblages	1	VIA-vPRG, Comune di Venezia
94	Landscape Units	1	Comune di Venezia, MAV, CNR-ISMAR Venezia, DSA
95	Surface Water Quality	3	ARPAV
96	Sediment Concentrations	2	MAV, Progetto ICSEL
97	Sediment Zoning in Cona Marsh	2	CNR - ISMAR Venezia
98	PCB Concentration	2	DSA - UniVE
99	Spatial Distribution of Ecological Risk Posed by Single Pollutants Arsenic, Cadmium and Nickel	2	MAV
100	Allochthonous Species in the Lagoon of Venice	3	Museo di Storia Naturale, CORILA
101	Conflict Between Uses	1	Osservatorio Naturalistico della Laguna - Comune di Venezia, MAV

102	Cumulative Impact Zones	1	Osservatorio Naturalistico della Laguna - Comune di Venezia, MAV
103	Environmental Compatibilty Area	2	Provincia di Venezia

8.4 Wintering Bird Census Form

MODULO CENSIMENTO UCCELLI ACQUATICI

WETLANDS INTERNATIONAL (ex IWRB) — *INTERNATIONAL WATERFOWL CENSUS* WESTERN PALEARCTIC

Si prega di restituire questa scheda compilata **entro il 31 marzo** a:
Istituto Nazionale per la Fauna Selvatica "Alessandro Ghigi"
Via Ca' Fornacetta 9 - 40064 - Ozzano dell'Emilia (Bologna)

NAZIONE: **REGIONE:**

NOME DELLA ZONA: **DATA:** ...../...../200.... (giorno mese anno)

IWRB SITECODE: **CODICE NAZ.LE:**

CENSITA IN PASSATO?: Si p No p

TIPO DI CENSIMENTO: AEREO A PIEDI IN BARCA MISTO ALTRO (cerchiare ove appropriato) PARZIALE COMPLETO

RILEVATORE:

MINACCE RISCONTRATE: 1. Nessuna X. Limitate Y. Gravi O. Non annotato

CONDIZIONI DELLA ZONA UMIDA: 1. Normale 2. Asciutta 3. Gelata 4. Disturbata

STROLAGHE **Contate? Si p No p**

GAVIM _____
GAVAD _____ *Gavia adamsii* Strolaga beccogiallo
GAVAR _____ ***Gavia arctica* Strolaga mezzana**
GAVST _____ *Gavia stellata* Strolaga minore
GAVIA _____ *Gavia* spp. Strolaga non identificata

SVASSI **Contati? Si p No p**

TACRU _____ *Tachybaptus ruficollis* Tuffetto
PODGR _____ *Podiceps grisegena* Svasso collorosso
PODCR _____ ***Podiceps cristatus* Svasso maggiore**
PODAU _____ *Podiceps auritus* Svasso cornuto
PODNI _____ ***Podiceps nigricollis* Svasso piccolo**
GREBE _____ *Podicipedidae* spp. Svassi non identificati

PELLICANI **Contati? Si p No p**

PELON _____ *Pelecanus onocrotalus* Pellicano
PELCR _____ *Pelecanus crispus* Pellicano riccio
PELEC _____ *Pelecanus* spp. Pellicani non identificati

CORMORANI **Contati? Si p No p**

PHACA _____ ***Phalacrocorax carbo* Cormorano**
PHAAR _____ *Phalacrocorax aristotelis* M. dal ciuffo
PHAPY _____ *Phalacrocorax pygmaeus* Marangone minore
PHALA _____ *Phalacrocorax* spp. Cormorani non identific.

AIRONI E GARZETTE **Contati? Si p No p**

ARDCI _____ ***Ardea cinerea* Airone cenerino**
EGRAL _____ *Egretta alba* Airone bianco maggiore
EGRGA _____ ***Egretta garzetta* Garzetta**
BUBIB _____ *Bubulcus ibis* Airone guardabuoi
NYCNY _____ *Nycticorax nycticorax* Nitticora
BOTST _____ *Botaurus stellaris* Tarabuso
ARDEI _____ *Ardeidae* spp. Ardeidi non identificati

CICOGNE, IBIS E SPATOLE **Contati? Si p No p**

CICNI _____ *Ciconia nigra* Cicogna nera
CICCI _____ *Ciconia ciconia* Cicogna bianca
PLEFA _____ *Plegadis falcinellus* Mignattaio
PLALE _____ *Platalea leucorodia* Spatola

FENICOTTERI **Contati? Si p No p**

PHORO _____ *Phoenicopterus roseus* Fenicottero

OCHE, CIGNI E ANATRE **Contati? Si p No p**

ANSFA _____ *Anser fabalis* Oca granaiola
ANSBR _____ *Anser brachyrhynchus* Oca zamperosee
ANSAL _____ *Anser albifrons* Oca lombardella
ANSEY _____ *Anser erythropus* Oca lombardella minore
ANSAN _____ ***Anser anser* Oca selvatica**
ANSER _____ *Anser* spp. Oche non identificate
BRACA _____ *Branta canadensis* Oca del Canada
BRALE _____ *Branta leucopsis* Oca facciabianca
BRABE _____ *Branta bernicla* Oca colombaccio
BRARU _____ *Branta ruficollis* Oca collorosso
CYGCY _____ *Cygnus cygnus* Cigno selvatico
CYGBE _____ *Cygnus columbianus* Cigno minore
CYGOL _____ ***Cygnus olor* Cigno reale**
SWANS _____ *Cygnus* spp. Cigni non identificati
TADFE _____ *Tadorna ferruginea* Casarca
TADTA _____ ***Tadorna tadorna* Volpoca**
ALOAE _____ *Alopochen aegyptiacus* Oca del Nilo
AIXGA _____ *Aix galericulata* Anatra mandarina
ANAPE _____ ***Anas penelope* Fischione**
ANAST _____ *Anas strepera* Canapiglia
ANACR _____ ***Anas crecca* Alzavola**
ANAPL _____ ***Anas platyrhynchos* Germano reale**
ANAAC _____ *Anas acuta* Codone
ANACL _____ *Anas clypeata* Mestolone
MARAN _____ *Marm. Angustirostris* Anatra marmorizzata
NETRU _____ *Netta rufina* Fistione turco
AYTFE _____ ***Aythya ferina* Moriglione**
AYTNY _____ *Aythya nyroca* Moretta tabaccata
AYTFU _____ *Aythya fuligula* Moretta
AYTMA _____ *Aythya marila* Moretta grigia
AYTHY _____ *Aythya* spp. Morette non identificate

Segue retro →

NOME DELLA ZONA:

DATA: . . . . . / . . . . . / 199 . . . .
giorno mese anno

POLST _____ *Polisticta stellerii* Edredone di Steller
SOMMO _____ *Somateria mollissima* Edredone
SOMSP _____ *Somateria spectabilis* Re degli edredoni
HISHI _____ *Histrionicus histrionicus* Moretta arlecchino
MELNI _____ *Melanitta nigra* Orchetto marino
MELFU _____ *Melanitta fusca* Orco marino
CLAHY _____ *Clangula hyemalis* Moretta codona
BUCCL _____ *Bucephala clangula* Quattrocchi
BUCIS _____ *Bucephala islandica* Quattrocchi d'Islanda
MERAL _____ *Mergus albellus* Pesciaiola
MERSE _____ ***Mergus serrator* Smergo minore**
MERME _____ *Mergus merganser* Smergo maggiore
OXYJA _____ *Oxyura jamaicensis* Gobbo della Giamaica
OXYLE _____ *Oxyura leucocephala* Gobbo rugginoso
DUCKS _____ *Anatidae* spp. Anatre non identificate

GRU **Contate? Si p No p**
GRUGR _____ *Grus grus* Gru

FOLAGHE E RALII **Contati? Si p No p**
Contata solo Folaga p
RALAQ _____ *Rallus aquaticus* Porciglione
PORPA _____ *Porzana parva* Schiribilla
PORPZ _____ *Porzana porzana* Voltolino
GALCH _____ *Gallinula chloropus* Gallinella d'acqua
PORPO _____ *Porphyrio porphyrio* Pollo sultano
FULAT _____ ***Fulica atra* Folaga**
FULCR _____ *Fulica cristata* Folaga crestata
FULIC _____ *Fulica* spp. Folaghe non identificate
RALLI _____ *Rallidae* spp. Ralli non identificati

LIMICOLI **Contati? Si p No p**
ROSBE _____ *Rostratula benghalensis* Beccaccia dorata
HAEOS _____ *Haematopus ostralegus* Beccaccia di mare
HIMHI _____ *Himantopus himantopus* Cavaliere d'Italia
RECAV _____ *Recurvirostra avosetta* Avocetta
BUROE _____ *Burhinus oedicnemus* Occhione
CURCU _____ *Cursorius cursor* Corrione biondo
VANVA _____ ***Vanellus vanellus* Pavoncella**
VANSP _____ *Vanellus spinosus* Pavoncella armata
PLUAP _____ *Pluvialis apricaria* Piviere dorato
PLUSQ _____ *Pluvialis squatarola* Pivieressa
CHAHI _____ *Charadrius hiaticula* Corriere grosso
CHADU _____ *Charadrius dubius* Corriere piccolo
CHAPE _____ *Charadrius pecuarius* Corriere pecuario
CHAAL _____ ***Charadrius alexandrinus* Fratino**
CHALE _____ *Charadrius leschenaultii* Corr. di Leschenault
CHARA _____ *Charadrius* spp. Corrieri non identificati
EUDMO _____ *Eudromias morinellus* Piviere tortolino
LIMLI _____ *Limosa limosa* Pittima reale
LIMLA _____ *Limosa lapponica* Pittima minore
NUMPH _____ *Numenius phaeopus* Chiurlo piccolo
NUMTE _____ *Numenius tenuirostris* Chiurlottello
NUMAR _____ ***Numenius arquata* Chiurlo maggiore**
NUMEN _____ *Numenius* spp. Chiurli non identificati

TRIER _____ *Tringa erythropus* Totano moro
TRITO _____ ***Tringa totanus* Pettegola**
TRIST _____ *Tringa stagnatilis* Albastrello
TRINE _____ *Tringa nebularia* Pantana
TRIOC _____ *Tringa ochropus* Piro piro culbianco
TRIGL _____ *Tringa glareola* Piro piro boschereccio
TRING _____ *Tringa* spp. Totani non identificati
ACTHY _____ *Actitis hypoleucos* Piro piro piccolo
AREIN _____ *Arenaria interpres* Voltapietre
SCORU _____ *Scolopax rusticola* Beccaccia
GALGA _____ ***Gallinago gallinago* Beccaccino**
LYMMI _____ *Lymnocryptes minimus* Frullino
CALCA _____ *Calidris canutus* Piovanello maggiore
CALAA _____ *Calidris alba* Piovanello tridattilo
CALMI _____ *Calidris minuta* Gambecchio
CALMA _____ *Calidris maritima* Piovanello violetto
CALAL _____ ***Calidris alpina* Piovanello pancianera**
CALID _____ *Charidris* spp. Piovanelli non identificati
PHIPU _____ *Philomachus pugnax* Combattente
WADER _____ *Charadrii* spp. Limicoli non identificati

GABBIANI E STERNE **Contati? Si p No p**
LARAU _____ *Larus audouinii* Gabbiano corso
LARCA _____ *Larus canus* Gavina
LARAR _____ *Larus argentatus* Gabbiano reale nordico
LARCH _____ ***Larus cachinnans mich.* Gabbiano reale**
LARFU _____ *Larus fuscus* Zafferano
LARMA _____ *Larus marinus* Mugnaiaccio
LARHY _____ *Larus hyperboreus* Gabbiano glauco
LARGL _____ *Larus glaucoides* Gabbiano d'Islanda
LARIC _____ *Larus ichthyaetus* Gabbiano di Pallas
LARME _____ *Larus melanocephalus* Gabbiano corallino
LARRI _____ ***Larus ridibundus* Gabbiano comune**
LARGE _____ *Larus genei* Gabbiano roseo
LARMI _____ *Larus minutus* Gabbianello
LARSB _____ *Larus sabini* Gabbiano di Sabine
LARUS _____ *Larus* spp. Gabbiani non identificati
CHLHY _____ *Chlidonias hybridus* Mignattino piombato
CHLNI _____ *Chlidonias niger* Mignattino
CHLID _____ *Chlidonias* spp. Mignattini non identific.
STECA _____ *Sterna caspia* Sterna maggiore
STEHI _____ *Sterna hirundo* Sterna comune
STESA _____ ***Sterna sandvicensis* Beccapesci**

RAPACI **Contati? Si p No p**
PANHA _____ *Pandion haliaetus* Falco pescatore
HALAL _____ *Haliaeetus albicilla* Aquila di mare
AQUCL _____ *Aquila clanga* Aquila anatraia maggiore
CIRAE _____ ***Circus aeruginosus* Falco di palude**
CIRCY _____ *Circus cyaneus* Albanella reale

ALTRE SPECIE
_____ _____ _____
_____ _____ _____
_____ _____ _____

NOTE: .....
.....
.....
.....