

## **Metabolism of Meperidine Hydrochloride (Demerol) and Mu-Opioid Receptors: Chronic Pain vs. Addiction**

Every day, chronic pain patients are accused of being addicted to the drugs that allow them to function as a normal individual. These accusations stem from the fact that pain medications, such as Demerol, are often abused by those individuals in society who do not have a chronic pain condition. Instead, these individuals use the drug for euphoric purposes. These accusations also arise despite the fact that the risk of addiction in patients without a history of addictive behaviors using opioids is <0.03 %. Pain patients are at very low risk of developing addiction to opioids if they have no prior history of substance abuse (Walker, 2008).

Chronic pain is a complex disease state which is complicated by physical, psychosocial, and spiritual suffering (Walker, 2008). Approximately 50 million people in the world experience chronic pain (Walker, 2008). Since chronic pain is such a widespread medical problem in the world today, we might expect that physicians and scientists around the world would be able to pinpoint exactly where chronic pain originates from. However, according to Yezierski, Radson and Vanderah (2004), pain scientists still aren't sure why chronic pain develops, but they do know that the longer pain stimuli acts on the central nervous system (CNS), chronic pain is more likely to develop.

There are two major pain pathways in the body. The ascending pathway runs from the peripheral nerves to the spinal cord, and the descending pathway originates in the brain stem and inhibits pain transmission neurons via compounds such as serotonin (Yezierski et. al, 2004). It is the descending pathway that is the target for effective chronic pain medications such as opioids (Yezierski et. al, 2004).

Although there are many treatments for chronic pain, including pharmacological and non-pharmacological methods, the most common treatment that physicians employ is the use of opioid analgesics (pain relievers). Opioid therapy is the mainstay of treating severe pain (Walker, 2008). According to Walker (2008), opioid analgesics act on different neuroreceptors (such as mu, delta or kappa) to produce analgesia (pain relief) in three ways: block the transmission of peripheral pain stimulation to the spinal cord, increase the inhibitory pathway in the spinal cord to change the transmission of pain, and modulate the limbic system response, which is the response of several components of the brain including the hippocampus and amygdala.

One such opioid analgesic used to treat chronic pain conditions is called Meperidine Hydrochloride, or Demerol as it is more commonly known. Meperidine hydrochloride is a narcotic analgesic that is very similar to morphine. Demerol works by suppressing the central nervous system, more specifically by acting on the mu-receptor in the brain to produce analgesia (Qualitest Pharmaceuticals, 2009). The mu-opioid receptors in the brain have been determined to play a central role in the regulation of sensory and affective components of the pain experience (Zubieta, Smith, & Bueller, 2001). Mu-opioid receptors are located in a number of cortical and subcortical brain regions, and interact with opioids during sustained pain (Zubieta, et. al., 2001). As previously mentioned, this is part of the descending pain pathway (Yezierski et. al, 2004).

As previously stated people who use opioid analgesics, such as Demerol, are constantly being accused of being addicted to them despite contradicting evidence. Before delving further into the mechanisms of addiction, it is important to understand what addiction really is. According to Cami and Farre (2003), drug addiction is a chronic, relapsing disorder in which drug-

seeking and/or taking behavior continues despite negative consequences. The continued use of addictive substances results in changes in the central nervous system ultimately resulting in tolerance, physical dependence, sensitization, craving and relapse (Cami & Farre, 2003). For the purpose of this study, addiction is defined as the use of pain medication to achieve a euphoric state, rather than to alleviate pain.

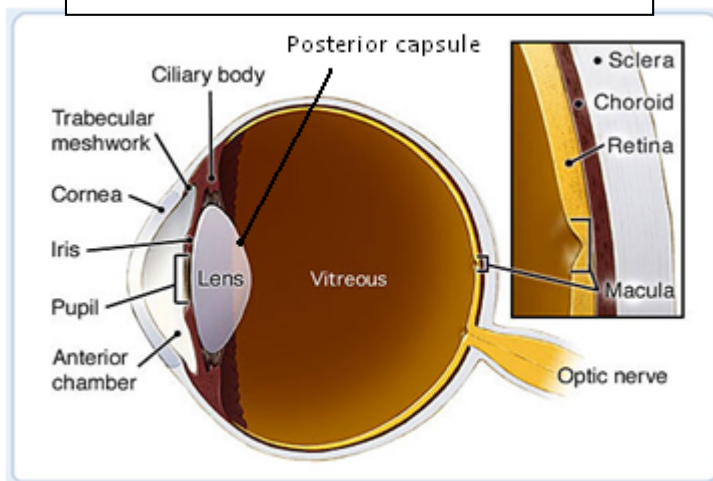
This research project that I am proposing will analyze the connection between the mu-opioid receptor in the brain related to Meperidine hydrochloride use under both chronic pain conditions, as well as the conditions that would suggest addiction. It is from this study that it will be shown that the two conditions (chronic pain and addiction) are unrelated in their interactions with mu-opioid receptors of the brain.

From this research project, I hope to be able to improve the quality of medical treatment that those people suffering from chronic pain conditions will receive by diminishing, and hopefully eliminating, the assumption that they are addicted to the pain medication that makes them capable of functioning on a day-to-day basis.

### **The effect age has on opacities forming on the posterior capsule after cataract surgery, in relation to the artificial lens used**

Throughout the world, blindness is caused most often by cataracts (1). Over 6 million patients are diagnosed with cataracts every year throughout the world and over one and a half million surgeries are done in the United States alone (1). Cataract surgery is the most common surgery performed in the US, and more than half of people over the age of 65 form cataracts (1). A cataract is formed when the lens in your eye becomes cloudy (5). The human lens is located in a capsule behind the pupil and the iris (figure 1). It will adjust to objects depending on how far away they are, allowing us to see objects at different distances (5). When a lens becomes cloudy it causes the light to scatter as it enters the eye and vision becomes impaired, because the light is

[http://www.ahaf.org/assets/images/anatomy\\_of\\_eye\\_border.jpg](http://www.ahaf.org/assets/images/anatomy_of_eye_border.jpg)



unable to focus on the retina (1). A cataract forms at different stages throughout your life and its formation depends on many different factors. Many factors increase the risk of cataract with the main cause being age (2). Other risk factors include the use of corticosteroids, systemic diseases such as diabetes, and being of the female sex (2). Some factors that are variable include smoking cigarettes and exposure to UV-B light (2). Sometimes after cataract surgery scar tissue forms on the posterior capsule (figure 1), and will once again hinder your vision, these are known as opacities. When this happens a follow up surgery is needed to clear this scar tissue enabling you good vision once again (5).

There are studies that have examined the formation of opacities on the artificial lens after cataract surgery has been performed (3). Opacities are the production of scar tissue that forms on the posterior capsule after the false lens is implanted within the cornea (3). One study found a direct correlation with the use of hypromellose and the formation of opacities found on the lens

after surgery (3). Hypromellose is a gelatin like substance that is used during surgery to protect the cornea (3). The affect hypromellose has on opacity formation is unknown but it is believed to be an underlying factor in some YAG patients (3).

In a cataract surgery it is sometimes necessary to do a follow up surgery that will clear opacities that form on the posterior capsule behind the lens (refer to figure 1). The natural lens of the eye greatly resembles a grape in that it has an outer skin and an inner more gel like material. During the cataract surgery doctors will remove the top layer and the gel-like substance which is the lens, leaving the posterior capsule to help support the new lens (5). Once the artificial lens is in place it may become blurry affecting the patient's vision once again. This is easily fixed with an Neodymium: yttrium-aluminum-garnet (ND: YAG) laser posterior capsulotomy which is a very simple surgery that utilizes yttrium, aluminum, and garnet, as concentrated beams of light that make a laser(5). The machine used in this surgery concentrates the laser beams at different powers in milli jolts, and then the doctor fires the laser as needed until the capsule is clear in a normal pupil diameter (5). It is an extremely safe procedure in that all of the beams of light must line up in order for it to effectively create an opening in your posterior capsule that has been glazed over (5). As with all surgeries there are some risks that are involved but are rarely seen, and most patients are able to go on with normal actions without delay (5).

There are many different lenses used in cataract surgery and all have their advantages and disadvantages. The lenses used at the facility being observed include: The Crystalens intraocular lens implant (IOL) is the most common lens used in the surgery center, it is the only FDA approved accommodating lens available in the United States and allows for flexing so that patients can see things at a variety of different distances (5). It is also made from a clear plastic material that, unlike other lenses, does not affect night vision. One hundred percent of all patients that took part in the FDA study could read newspaper print without the use of glasses (5). Other lenses used are known as multi-focal lenses; they include the Acrysof ReSTOR lens and the REZOOM lens (5). The ReSTOR lens offers different ranges of vision depending on the placement of the lens within the eye (5). This is used for patients that want a lens specifically for reading or looking at object further away. The REZOOM lens is made in a special way that allows patients to see in a variety of different light conditions, a problem with the other multi focal lens (5). This lens does take time for the brain to get used to and often patients notice halos, rings, or glares around lights, although these symptoms tend to go away after a few weeks (5). The last lens discussed here is known as the ACRYSOF Toric implant (5). This is a lens designed for people that have astigmatisms in one or more of their eyes. (5).

In this study I plan to research the affect that age, and lens type, has on producing scar tissue on the posterior capsule after a cataract surgery. This will allow us to possibly suggest different lens to patients depending on their age. This is important to the ophthalmology department in that patients of all different ages may require cataract surgery. My hypothesis is that the younger the patient is, the faster he/she will generate scar tissue on the posterior capsule behind the newly inserted plastic lens and therefore will require a YAG sooner than those who are older. I also believe that the adjustable implants, the Crystalens and the ReSTOR that allow sight at various distances, will cause the formation of opacities slower than those that sit on the capsule, allowing only distance vision. I will analyze the data for a relationship between age and length of time between cataract surgery and YAG surgery, along with the type of artificial lens used.

## Using High Performance Liquid Chromatography to Monitor the Destruction of Valinomycin by Photocatalysis

In 2001, following the attack on the World Trade Centers, several letters containing traces of chemical toxins were mailed throughout the United States. Ever since this incident, there has been an increased awareness among the US population of the possibility of a terrorist attack on our nation via biological chemical weaponry (Steve Connor, 2002). Currently, there is work being done with one specific biological compound, Valinomycin, to develop a safe and effective method to destroy it by titanium oxide photocatalysis (Baretto 2009).

Valinomycin is a cyclododecadepsipeptide which in small concentrations is used as an antibacterial agent because it regulates the transport of potassium ions across biological membranes (Park et al., 2008). However, this property of Valinomycin can become deadly when it is present in higher concentrations. When this thirty-six-membered ring begins targeting cells

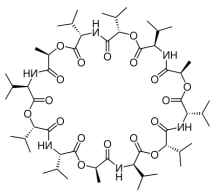


Figure 1: Valinomycin

other than bacteria, it can induce apoptosis, or programmed cell death, in human “killer” cells (Paananen, et al., 2000). These natural killer cells can be thought of as the first line of defense in the immune system due their ability to kill abnormal cells and activate other aspects of the immune response (Paananen, et al., 2000). Valinomycin may destroy the membrane potential in

neural and cardiac cells as well (Paananen et al., 2005). The folded shape of this compound forms a cavity that is selective for accommodating a potassium ion which is then transported across the inner membrane of mitochondria. High concentrations of Valinomycin transport too much of this ion, which can induce apoptosis in several different types of mammalian cells (Paananen, et al., 2000). Valinomycin specifically presents a concern to those interested in potential bioterrorist weapons because it is naturally occurring and can be easily obtained since it is produced by bacteria commonly found in indoor air and dust (Paananen, et al., 2000).

Thin film Photocatalysis is one method that has been proposed for safely destroying this compound. This method has already shown itself to be successful in the destruction by degradation of other toxins, as well as bacteria such as *Escherichia coli*, which has a similar structure and behaves similarly to Valinomycin (Sunada, et al., 1998). According to research done, once titanium dioxide has been irradiated with ultraviolet light, it is able to degrade most organic compounds because the strong oxidation breaks the bonds holding the compounds together (Sunada et al., 1998). What is still needed in this area of developing research is a reliable method to determine whether the TiO<sub>2</sub> photocatalytic method of destruction is fully degrading Valinomycin to the point that it can no longer transport potassium ions across the mitochondrial membrane. If this compound is used in the future as a chemical weapon, a strong level of confidence is needed to determine if the contaminated area has been rid of dangerous toxic levels.

The method that is being proposed to analyze the degradation of Valinomycin is High Performance Liquid Chromatography (Baretto, 2009). This analytical method separates a mixture of compounds, and different compounds are emitted from the column at different times (Christian, 2003). It can be used to detect whether or not the TiO<sub>2</sub> photocatalysis has been effective in destroying Valinomycin because the cyclic structure of Valinomycin will elude in a much different way than the straight-chain formation that would be formed if the photocatalysis is effective.

## Ecosystem Ecology

### **How Carbon is stored in a slash pine forest and the effects on carbon once the forest is removed?**

The start of the industrial revolution brought an increase in concentrations of CO<sub>2</sub> in the atmosphere (Wu, et al., 2006). Anthropogenic activities such as burning of fossil fuels; including oil, coal and natural gas; has released carbon that has been locked inside the earth for millions of years back into the atmosphere. Soil, forests and oceans absorb some of this carbon while the rest stays in the atmosphere where carbon acts as a greenhouse gas (Carraway, et al., 2007).

Forests play an important role in the carbon cycle. Forests can function as a carbon sink, when they take up CO<sub>2</sub> from the surrounding atmosphere during normal photosynthetic activity (Wu, et al., 2006). The Carbon is stored in various forms throughout the tree for example biomass, leaf litter and soil and it can be stored in forests for an undetermined amount of time (Stainback and Alavalapati, 2002). When forests are removed or burned the carbon that has been stored in the forests are then released back into the atmosphere. Removing forests not only increases the amount of carbon in the atmosphere but also lowers the amount of potential carbon that can be sequestered (Loescher, et al, 2006). For example a great deal of deforestation is being done in the rainforests of South America. All of the carbons stored by these forests is now being released back into the atmosphere and is difficult to be sequestered because lack of remaining forests (Luyssaert, et al., 2008).

Slash Pine (*Pinus elliottii*) is found in Florida, West Indies, Guatemala and Honduras. It grows in sand hills, flatwoods and near wet lowlands. Slash Pine has a rapid growth rate and live in ecosystems that do not require many nutrients. Their ability to grow so rapidly, gives them a great potential for sequestering atmospheric Carbon, making them an ideal species to study (Loescher, et al., 2006).

The increase in carbon in the atmosphere is a pressing issue that our society is currently facing. The rise of industrialism, consistent development and the mass deforestation occurring, has launched a huge green movement that is striving to reduce CO<sub>2</sub> emissions. Previous studies have shown that the average total carbon storage in a Slash Pine forest is 291.663 tonnes hm<sup>-2</sup> (Xi, et al, 2006). I propose to expand on the effects that increased forest removal has on the carbon cycle and how much carbon is being released back into the atmosphere by the removal of forests. Ultimately this study will address why we should put more effort on trying to decline carbon levels in the atmosphere and how forests can play an important role in declining these levels.

### **The Relationship between Forest Composition and Hydrology in an Urbanized Cypress Slough Preserve**

Cypress wetlands compose 10 to 15% of Florida's natural areas (Brown, 1981). Six Mile Cypress Slough represents a prime example of wetland loss in Florida. The historic watershed traditionally covered 14,500 ha and today covers approximately 8,500 ha, making for a 41% reduction in watershed area (Key, et al., submitted). This drastic change will impact the functioning capabilities of the slough (Key, et al., submitted). Covering 1,100 ha, Six Mile Cypress Slough is completely surrounded by residential and commercial development and intersected by four major roads (Key, et al., submitted). This habitat fragmentation has led to alterations in hydrology, such as changes in sheet flow, runoff from paved surfaces, and construction of manmade water control

mechanisms (Key, et al., submitted). Hydroperiod drives vegetation dynamics; changes in hydrology create changes in vegetation. (Key, et al., submitted). While solar energy is the primary drive for productivity, auxiliary energy from water flow, water level fluctuation, nutrient inputs, sediment transport, and geomorphologic structure play an important role in production (Brinson, 1981). Vegetation is an important indicator in the overall health of an ecosystem. Limited research on vegetation dynamics has been conducted at Six Mile Cypress Slough. It is important to track and document changes in vegetation dynamics to better understand how encroaching urbanization is negatively affecting the functioning capabilities of Six Mile Cypress Slough.

In order to obtain a better understanding of vegetation dynamics within Six Mile Cypress Slough, I will look at Cypress, (*Taxodium distichum*) as this is the most dominant species within Six Mile Cypress Slough. Other species typically found in the Slough, such as wetland hardwoods, have difficulty contending with extreme soil-moisture conditions, and are therefore less abundant (Dickson, 1972). Keeping in mind that hydroperiod drives vegetation dynamics, I propose to determine whether hydroperiod accurately predicts distribution of cypress and the possibility of sustaining a cypress dominated forest (Key, et al., submitted).

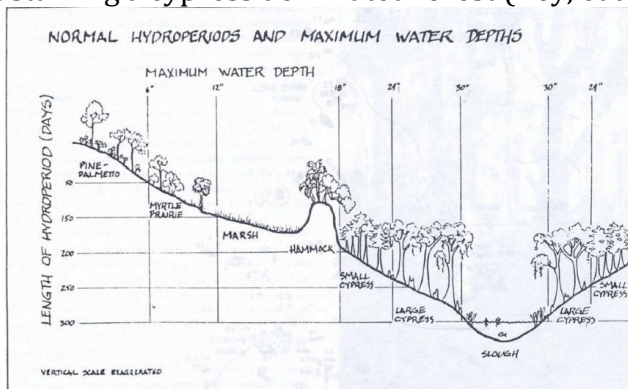


Fig.1 Normal Hydroperiods and Maximum Water Depths in cypress habitats (Wharton et al., 1977)

## Conservation Biology

### **The Effects of Pollution on Bottlenose Dolphins in Florida**

With human populations increasing, coastal environments are getting more and more crowded. There is a high desire to live near the beaches and have a boat here in SW Florida. Along with humans come more degradation and all kinds of pollution. Humans have created a lot of pollution that contaminates the water coming from their roads, parking lots and any other surface that contributes to runoff, even pesticides runoff and seep into the water. Pollution effects on bottlenose dolphins in FL are happening and needs to be further examined to find solutions to the problem.

The bottlenose dolphin is a very well-liked marine mammal. People want to protect this fascinating species from any harm. The bottlenose dolphin, *Tursiops truncatus* is the biggest of the beaked dolphins. It weighs anywhere from around 400-1,000 pounds. Dolphins travel broadly to find food and ideal temperatures at speeds of up to nineteen kph. Dolphins also create click-like sounds which are produced by nasal sacs in their forehead for echolocation so they can communicate and locate things. In SW Florida along the Gulf of Mexico there are many sightings of bottlenose dolphins. They are typically found off the coasts of Hawaii and Florida all year-round. The bottlenose dolphin is fond of warm, shallow inshore waters. Bottlenose dolphins are frequently seen in bays and lagoons. They all have similar diets which includes things like squid, shrimp, eels, and a wide variety of fishes. Dolphins often hunt as a pod, by herding small fishes ahead of them and picking off the stragglers, survival of the fittest.

The major concern of this research is going to focus on pollution; toxic chemicals that harm the bottlenose dolphin. Common bottlenose dolphins in coastal areas are exposed to a wide variety of threats. Some threats that should be of huge concern would be chemicals and degradation. First the toxic effects of chemicals; humans create chemicals and do not realize it could be harming the environment and its impact on species. Another threat is reduced prey availability which happens by environmental degradation and over fishing, they need food in order to survive, again something else humans can prevent. Thirdly, the threat of direct and indirect disturbance or harassment. This comes from entertainment attractions (such as a marine mammal show or feeding tank for people to have contact with them.) Another threat is marine construction and demolition and lastly other forms of habitat destruction and degradation. These threats, and possibly more we haven't discovered yet, can be creating an unsuitable habitat for bottlenose dolphins and causing ultimately a decrease in populations across different domains. These conditions need to be further researched because in many cases there is a lack of historical data which reduces our understanding of what will result in the future. Environmental contaminants have been studied and are known to impact health and reproductive success of other lab animals so what about the common bottlenose dolphins? Concentrations of PFCs, PCBs and DDT chemicals in the blood of inshore bottlenose dolphins correlate with the decline in immune system function which states that it is not healthy for the species to be exposed to. Previous studies show in a risk assessment relative to PCB burdens that it suggests high probabilities of first-born mortality at several sites in the U.S. Chemicals have the power to affect reproduction of the species and therefore should be prevented.

There are many ways humans create pollution in FL. Water quality is decreasing due to run-off of chemicals from our land and trash swept into the waves. There is nothing positive from pollution; it comes from many different substances that are being found in places where they just

do not belong. In our waters, pollution being found includes household pesticides, fertilizer runoff, parking lot runoff such as gasoline and oil, an overflow from industrial ponds that may possibly include poisonous substances that are very harmful and unknown to the environment even biological waste from animal farms and septic tanks. Different types of pollution have a variety of diverse consequences, some not as deadly as others but still none are acceptable. For example too much fertilizer pollution makes algae and plants grow excessively and change plant community structure and possibly remove other species. Research shows how just a single gallon of gasoline makes tons of gallons of water unfit for us to drink! Pesticide pollution can seep into the sediments and water table and begin killing small aquatic animals and poison inhabited wildlife. As we can see, contaminants in many cases we created can cause significant short-term and long-term effects in any body of water where they are introduced, and once introduced it is even harder to clean them out.

Another research article was done in Biscayne Bay in Miami FL and can clearly prove chemicals were found in the dolphins tested. Bottlenose dolphins (*Tursiops truncatus*) are long-term residents and apex predators in southeast U.S. estuaries and are vulnerable to bioaccumulation of persistent organic pollutants (POPs). Dart biopsy samples were collected from 45 dolphins in Biscayne Bay (Miami, FL), 34 of which were matched using fin markings to a photo identification catalogue. Blubber samples were analyzed for 73 polychlorinated biphenyl (PCB) congeners, six polybrominated diphenyl ether (PBDE) congeners, and organochlorine pesticides including dichloro-diphenyl-trichloroethane (DDT) and metabolites, chlordanes, and dieldrin. Total PCBs ( $\Sigma$ 73PCBs) were present in the highest concentrations and were 5 times higher in males with sighting histories in the northern, metropolitan area of Biscayne Bay than males with sighting histories in the southern, more rural area [geometric mean: 43.3 (95[percent] confidence interval: 28.0-66.9) vs 8.6 (6.3-11.9) mg/g wet mass, respectively]. All compound classes had higher concentrations in northern animals than southern. The differences in POP concentrations found on this small geographic scale demonstrate that differential habitat use can strongly influence pollutant concentrations and should be considered when interpreting bottlenose dolphin POP data. The PCB concentrations in northern Bay dolphins are high as compared to other studies of estuarine dolphins and may place these animals at risk of reproductive failure and decreased immune function. O'Shea also mentions environmental contaminants in his research paper. Marine mammal die-offs and morbidity events from harmful algal blooms that seem to be increasing with runoff and other coastal ecosystem changes (Van Dolah 2005; Van Dolah et al. 2003); and an expanding list of chemical contaminants synthesized by humans. Indeed, a few of today's surviving long-lived marine mammals may have been born in seas almost completely free of persistent organic pollutants, given that large-scale use of organochlorine pesticides such as DDT and industrial compounds such as polychlorinated biphenyls did not occur until the 1940s or later (O'Shea and Tanabe 2003). Today such compounds are likely to be found in every marine mammal on Earth, and are spread to arctic ecosystems from developed areas not only through marine food chains but by atmospheric transport on the winds (Simonich and Kites 1995). (O'Shea, Thomas 2008)

My project is going to benefit the marine environment for bottlenose dolphins. This research is going to be about monitoring PFC chemical concentrations to learn how to prevent it and minimize its harm to benefit bottlenose dolphins, and to learn more about its affects on bottlenose dolphins. PFC chemicals are man-made and found in nonstick coatings in goods such as furniture fabrics, carpets, cosmetics, cookware and even fire-fighting foams. These chemicals are known to be incredibly stable and persist for a very long time in the environment. Previous



experiments say that it can be poisonous to the liver, reproductive organs and immune systems of lab animals. Toxic chemicals can cause people to become very ill as well, not just animals. This research will help save the bottlenose dolphin from becoming endangered and help them reproduce without failures and mortalities. This research will educate anyone how much humans impact the environment in very specific ways. It will clarify the larger picture of overpopulation and what it affects in our environment. Everything is interconnected. I predict that the coastal areas that are very populated have surrounding waters with higher toxic chemicals, therefore leading to negative effects bottlenose dolphins in those areas compared to others with less people.

### **Conservation of Florida Manatee: How the Florida Manatee is affected by red tide.**

Red tides are classified as algal blooms which can be harmful. These algal blooms are a dinoflagellate *Karenia brevis*. (Maucher, 2007) The dinoflagellate produce a variety neurotoxins referred to as brevetoxins which cause an uncontrolled sodium influx. (Fleming, 2005) Exposure to brevetoxins can affect a variety of organisms, from filter feeding shellfish to protected marine mammals and humans. Effected organisms can be affected either directly by ingesting the dinoflagellate or indirectly through trophic transfer and bioaccumulation of the toxin (Maucher, 2007).

The event of red tide occurs annually around the coast of Florida, specifically in the Gulf of Mexico, and usually in the fall months. Sometimes algal blooms like the one seen in the Gulf of Mexico can be seen as far north as North Carolina. (Fleming, 2005) I figure there will be more toxins in the blood stream, because more toxins will show up in the blood stream if the toxin is carried by an aerosol rather than if it is digested.

The dinoflagellate *Kbrevis* can be easily broken by the waves motion, which is what release the brevetoxins into the marine water. (Fleming, 2005) At the surface of the water the brevetoxin can become an aerosol and be carried by the wind to many different locations. With the wind currents the toxins can spread as far north as North Carolina, and as far west as the east coast of Texas. (Potera, 2007)

Experiments that have been done on animals with regards to the brevetoxins show that these toxins are known to localize in the cerebellum. ( Potera, 2007) Some algae will experience an occasional bloom or growth. When these algal blooms occur there can be different concentrations of brevetoxins in the air, which can cause respiratory symptoms in humans and animals. (Potera, 2007) Florida Red tide can be very unpredictable, and could occur at any time if the qualities need for a red tide algal bloom were to occur. (Potera, 2007)

Manatees are marine mammals that are sometimes refereed to as sea cows. (Langtimm, 1998) A manatee usually has a small litter of only one calf, their gestation is a long twelve month period. Manatees also breed only once a year because the mother takes care of the calf for another twelve to eighteen months while the calf is weaned. (Langtimm, 1998) Manatees have been known to have a long life span that can range up to 60 years. (Langtimm, 1998)

All manatees are herbivores that feed on aquatic vegetation. (Langtimm, 1998) Florida manatees (*Trichechus manatus latirostris*) are herbivores and are one of the best studied sirenians. (Marshall, 2000) Herbivores are know for their generalized feeding habits and may ingest more than 60 species of freshwater and marine plants such as mangrove ,turtle grass, and types of algae, using their divided upper lip. (Marshall, 2000) An adult manatee will generally eat up to 9% of its body weight per day. (Marshall, 2000) Manatees being mainly herbivores spend most of their time grazing in shallow waters and at depths of 1-2 meters (3-7 ft). (Marshall, 2000)

Manatees possess a short muscular snout that is covered by short sinus hairs and modified vibrissae or bristles. (Marshall, 2000) Manatees are unique because they use these perioral bristles in conjunction with elaborated facial musculature to bring plants into the mouth. (Marshall, 2000) Manatees use this muscular complex to manipulate a diverse range of structural forms among aquatic plants. (Marshall, 2000) Like all mammals, manatees breathe air. As a marine mammal, they must rise to the surface to take a breath. Manatees come up to take a breath approximately every 20 minutes when they are resting or in low motional movements, when a manatee is very active it requires more air just like humans do so it comes to the surface for a breath every three to five minutes during activity. (Marshall, 2000) Manatee breathing is a lot different than human breathing. When a manatee breaths it can change 90% of the air in its lungs while a human is more limited and can only change about 10 % of the air in its lungs. (Marshall, 2000) When a manatee does this they exhale very hard and very rapidly when their nose reaches the surface. Breathing like this means there is more fresh oxygen in their lungs, and allows the animal to stay underwater longer between breaths. (Marshall, 2000) Manatees can generally have a mean mass of 900-1200 lb., and mean length of 9-10 ft. Female manatees are usually longer and heavier than male manatees. When born, baby manatees have an average mass of 30 kg. (Marshall, 2000)

Marine vegetation has a greater salt content than freshwater aquatic plants. (Ortiz, 2000) Fish and sea grasses have been seen to accumulate high concentrations of brevetoxins. (Flewelling, 2005) Sea grasses have acted as toxin vectors during recent deaths of dolphins and manatees. (Flewelling, 2005) Analysis of seagrass that has been collected in previous studies show the accumulation mechanism could involve active uptake or passive adsorption of the toxin. (Flewelling, 2005)

In this project I purpose to look at how red tide is affecting the Florida Manatee. Red tide may also be affecting the Florida manatee because they are air breathing mammals that must come to the surface, where they are breathing in the red tide particles which are causing respiratory problems, similar to the ones that are being found in humans. (Marshall, 2000) It is also being seen that during occurrence of red tide humans are having more asthma and respiratory issues.

## Social Science

### **How regulation and policy affect the recreational fishing industry in southwest Florida**

Recreational fishing is an important source of income for the state of Florida, bringing in \$7.5 billion to the states economy in 2006 (FWC, 2009). There is mounting concern about the possible effects of fishing on the marine environment. "Both commercial and recreational fishing have greatly expanded in south Florida in terms of effort and landings, largely reflecting an economy dependent upon tourism" (Ault et al., 1998; Schittone, 2001). "In 2000, over 25 million recreational fishing trips were made in Florida (43% on the east coast and 57% on the west coast) and over 64 million pounds of recreationally caught fish were landed" (NMFS, 2001). "Recreational fishing is a particular management challenge because of the numbers of targeted species, multiple access points for vessels, and gears used, but also because of the absence of limitations on the number of recreational fishing licenses sold" (Bohnsack et al., 1994). "Recreational fishing increasingly resembles commercial fishing as technological improvements are adopted (e.g. better hydroacoustics, global positioning systems) that lead to increases in effective fishing power" (Bohnsack, J.A. and Ault, J.S., 1996). Unregulated fishing can lead to the exploitation of certain fish species and potential disruption of the local ecosystems. As a result of its importance to the state of Florida's economy, methods and measures have been taken to ensure the quality and sustainability of the industry for years to come. These include minimum size limits, closed seasons, and bag limits of local species so that populations are not exploited. Funds generated from saltwater fishing license sales go toward improving and restoring fish habitat and for marine fisheries research, law enforcement, and public education on marine resources.

Current regulations of salt water fishing may be unclear or unbeknownst to the common angler. Rules are made, changed and repealed throughout the year and agency staff often interacts with affected individuals and the general public (FWC, 2009). The FWC abides by Ch. 120, Florida Statutes, when making rules. They notify the public of rulemaking activity through the Florida Administrative Weekly. "Rulemaking often includes direct contact with those who may be affected, extensive discussions with stakeholder groups, and public meetings to gather input from interested parties" (FWC, 2009). According to FWC officer JoAnne Adams some of the most common violations for recreational fisherman include possession of illegal snook, grouper, snapper, redfish, spotted seatrout, and sometimes tarpon.

To ensure the quality of the industry and the effectiveness of current policy and law a survey will be conducted with active fishermen in the SW Florida area, from Naples to Ft. Myers beach. The study will show whether there is any correlation between fishing regulation knowledge and the amount of tickets being issued. It is important to understand the knowledge that anglers have on the issues and what kind of prior education they may have received. Florida ranks as the state with the second highest nonresident fishing days (Fedler & Ditton, 2000). The migration of seasonal residents (October-April) might very well make up for the high nonresident fishing days we see. My hypothesis is that fishing violations increase during seasonal months because of the influx of tourists and seasonal residents to the area and the lack of knowledge of fishing regulations they bring with them.

### **Impact of Community Gardens in Urban Southwest Florida**

In 1994, approximately 45% of the world's population lived in urban areas; this is a number that is projected to rise to 65% by 2025 (Belevi & Baumgartner, 2003). People are moving into urban areas to look for work to support themselves and their families. This migration is changing the way people are getting their food. We are moving away from where our food has traditionally been grown, and we need to look at alternative, more sustainable ways to acquire our food.

Urban agriculture is one way that urban populations have developed to connect themselves to their food. Urban agriculture is defined as an entire food process from growth to distribution that takes place within or on the edge of an urban area (Belevi & Baumgartner, 2003). There are many benefits of urban agriculture, and its importance as a food source for city populations is increasing. Urban agriculture contributes to environmental sustainability by decreasing the distance food travels before it is consumed. When built in empty areas, such as empty lots or areas by canals, gardens can contribute to the beautification of cities. Gardens provide a place for people to gather and work together to create something positive. Urban agriculture is important for city populations to acquire food and reduce poverty. Food grown in these gardens can enhance the diets of families and provide balanced nutrition. Low-income urban residents are more likely to purchase foods that are high in starch and fat and low in nutritional value; large quantities can be purchased for a small amount of money (Hendrickson et al., 2006). Eating this food for long periods of time leads to nutritional and health problems. Supplemental produce from community gardens can help people avoid future health problems. Urban agriculture has the potential to benefit not only low-income communities, but middle-income areas as well. Although residents of middle-income communities will not rely solely on their gardens for food, they can still benefit by connecting to their environment, their community and their food.

Agriculture in the United States is currently becoming larger and more commercial. Most large farms degrade the land by depleting nutrients and polluting the soil (Hanson et al, 2008). A shift to urban agriculture in the United States would reduce the reliance on unsustainable farming practices. As more people move to urban areas, more resources are being used in food distribution. Numerous community gardens are currently located in major cities around the United States. Urban agriculture ranges in size from a small window garden to an entrepreneurial garden where crops are grown to sell (Brown et al., 2000). There are a variety of spaces used and methods practiced. Most of the land is not owned by the gardeners, but permission is acquired from the local government or landowner. Some methods include using roofs as areas for gardens in urban areas (Oberndorfer et al., 2007). Other areas that can be utilized as gardens are alleys, land under power lines, and spaces along sidewalks and waterways (Irvine, 1999). Other futuristic sounding ideas include vertical skyscraper gardens and buildings with double-paned windows filled with plants (Vogel, 2008).

There are many problems associated with urban agriculture. Due to the numerous urban factors, contaminated soil, pollution, waste management, theft, and low water supply are all issues that can make urban gardening problematic (Altieri et al., 1999). In the United States, resources are not as scarce; some of these problems mainly arise out of developing countries. Many urban agriculture efforts are also stopped by local policies and governments. Crops may be destroyed by official due to policies regarding law use. Governments sometimes do not support urban agriculture efforts because they see it as primitive thinking (Drakakis-Smith et al., 1995).

The majority of the literature about urban agriculture focuses on its use in developing countries. There are many articles that look at the development of and problems associated with urban agriculture in places such as Havana, Harare, Mexico City, and Bangkok (Altieri et al., 1999,

Chaplowe, 1998, Drakakis-Smith et al., 1995, Fraser, 2002, Losada et al., 2000). Urban agriculture has especially been successful in Havana, Cuba, where it is considered a necessity for food acquisition due to the economic crisis when the Soviet Union fell (Altieri et al., 1999, Chaplowe, 1998). There has also been a very successful community garden project in Bangkok, Thailand (Fraser, 2002). The project was able to build community, create connections between citizens and local government officials, develop a model for future urban garden projects, and increase environmental awareness.

Presently, the literature lacks information on urban agriculture in so-called “developed” countries, in particular the United States. Most of the research concerning urban agriculture in “developed” countries has been done in Europe. Some research in Austria examines urban dwellers harvesting their own produce from farms outside the urban area, but it does not specifically address growing food inside a city (Vogl et al., 2004). There is also some literature concerning Canada. One example is the Alex Wilson Community Garden in Toronto, Ontario, which was examined as an example of sustainable urban development (Irvine, 1999). Although there has been research concerning urban agriculture, there is still a gap in the quantitative analysis of the impact of urban agriculture in the United States.

In this study, I propose to provide valuable information on the impact of urban agriculture on low income and middle income communities in Southwest Florida. The impact on both communities is of interest, because they both benefit in different ways. South Florida is a unique area where agriculture flourishes, but the fragile environment is degraded due to wide spread unsustainable agriculture. More food grown inside urban areas could lead to less land needed to grow food outside of these areas and the possibility of ecological restoration. This project seeks to quantify the impact of a community garden in order to establish its relevance for future use. This will fill the gap of information addressing urban agriculture in the United States and in particular, Florida. Research on urban agriculture is beneficial to society because it has the potential to relieve hunger and reduce poverty, and it has environmental benefits. Information from this project could promote a shift to urban agriculture in Southwest Florida.

### **What factors influences people to take-up chemical-based vs. organic gardening in S.W. FL?**

Gardening has been around for the past 13,000 years and still is going strong (Diamond, 2002). Gardening emerged from agriculture and domestication in Southwest Asia's Fertile Crescent during this time (Diamond, 2002). In the United States and other developed countries, gardening has become a hobby instead of a necessity. Individuals who put the time and effort into gardening find the rewards to be quite abundant.

One of the advantages to gardening is knowing where your food has come from (Brom (2000). Many gardeners take up the hobby to bridge the gap between the food producer and consumer (Brom 2000). For example, many gardeners share concerns about genetically modified food that come from commercial growers (Brom 2000). Another advantage of growing food is the having fun (Kaufman, 2004). Working with a garden puts a person outdoors, which may provide a calming, fun-learning experience (Kaufman, 2004). Gardening can stimulate the mind, giving a person needed time to rest, experience, and interact with life (Kaufman, 2004). For example, the butterfly frequently visit flowering gardens, which may give people a sense of peace, possibly getting that person ready for the day (Kaufman 2004).

Broadly speaking, there are two types of gardeners, a chemical-based gardener and an organic gardener. Chemical-based gardeners use fertilizers, chemical application, and pesticides

to increase the yield of their garden. By comparison, organic gardeners do not use chemical applications or pesticides to grow their gardens. Organic gardeners use manure or dead organic matter as a fertilizer substitute. To prevent pests, organic gardeners employ natural means to control garden pests, including the introduction of natural predators to keep the pest's number to a minimum. Finally, to keep a well-maintained garden the organic gardeners remove weeds by hand instead of using the chemical weed remover of a traditional gardener.

There are many factors that could influence whether a gardener pursues organic or chemical-based techniques, including family, health concerns, economics, time management, and environmental priorities. Family and culture may be an influencing factor (Lipske, 1998). A person could be put off to gardening if they experienced a neighbor's messy attempt to be an organic gardener. This left the future gardener with a desire to pursue chemical-based gardening (Lipske, 1998). For example the Burrow's family had a garden that had termites infested in it according to their neighbors (Lipske, 1998). The neighbors said the termites came straight from the Burrow's garden to their house (Lipske, 1998). Under these conditions, we might expect the neighbors to pursue chemical-based activities (Lipske, 1998). Culture may also be an influencing factor (Ross, 2008). For example, Chinese culture appears to promote gardening because of an emphasis on Zen philosophy, which believes in beautifying nature (Simons, 1991).

Health is another factor that might influence how an individual gardens (Devine, 2005). For example, a person can burn around 180 calories per 30 minutes of weed pulling (Devine, 2005). Consequently, this person might be expected to pursue organic gardening (Devine, 2005). A person's economic stability may also influence how they garden (Gehring, 2005). For example, individuals may adopt cheaper alternatives for pesticide, encouraging their take up of chemical-based gardening, especially during a recession (Gehring, 2005). Time management may also influence how a person takes up chemical-based gardening vs. organic gardening (Shields, 2002). A person with less time may decide to use chemicals for fertilize and control pesticides (Shields, 2002). In contrast, individuals with more expendable time might be expected to take up organic gardening (Shields, 2002). Gardeners may also be influenced by their environmental priorities (Spencer, 2008). For example, people concerned about waste and trash may consider organic gardening to get rid of unwanted waste in a compost pile (Spencer, 2008).

In this study, I will determine whether the five factors (family/ culture, health, economics, time management, and environmental priorities) influence how a person gardens. This study will provide insight on what factors may be influencing a person's decision to take up chemical-based versus organic gardening.

**Using the Fossil Record to Determine Prehistoric Sea Levels: An Alternative Method to Traditional Geologic Means.**

In essence, the problem that all paleontologists face is putting the pieces of history back together in a way that makes sense in reference to previously gathered information that appears to be set in stone. By nature, this problem is one that cannot be solved or worked through with a traditional experiment in the normal sense, as fossilization is a process that can take an immense amount of time depending on the conditions in which the organism died, and so must be undertaken with great care, as it's impossible to replicate true fossil evidence through the technological means that we have right now. The problem I face in my research endeavor is trying to fill in some of those pieces of Florida's geologic and prehistoric history, and offering to the scientific community a rough timeline in relation to the fossil history itself, as opposed to other geologic forces, such as those closely related directly to continental drift, as well and informatively noted in Palmer's Illustrated Encyclopedia of the Prehistoric World.

The geologic history of the Earth has been well-documented by way of methods and concepts revolving around plate tectonics (Condie 1997), and climatic evidence but I believe that using the fossil record of extinct plants and animals is also an equally valid way of doing the same thing. In my case, this is documenting the rise and fall of sea levels around a certain area, as well as making connections from the past to the present in terms of animal and plant evolution. Many things can be learned from the fossil record outside of the strict boundaries of what I am proposing as well, connections from extinct organisms and their living relatives that can be inferred from the physical information in body structure in the fossils (Levin 1999), as well as from environmental similarities from current information already gathered by others. By using sea levels, as well as already-existing climate information found in rocks and ice cores (Bjornerud 2006), tree rings (Fritts 1966), fossilized pollen (Bennett 1997), and even sediments, it is possible to create a fairly accurate picture of a prehistoric environment and what Earth must have been like in the ancient past.

I hypothesize that I will be able to complete the creation of a rough geologic timeline of sea levels within the time span of a year, adding to the knowledge of the scientific community of the creatures that used to roam the area of Florida in prehistoric times, utilize a method that seems to be less-studied than others in the field, and from doing that, gain a wider understanding about the aquatic environments of prehistoric Florida.