EFFECT OF SHORT-TERM ESTROGEN DEPLETION ON COMPACT BONE
MICRODENSITOMETRY IN THE EWE

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ABSTRACT

EFFECT OF SHORT-TERM ESTROGEN DEPLETION ON COMPACT BONE MICRODENSITOMETRY IN THE EWE

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Osteoporosis affects the human skeleton through the direct effects of the disease on the function and structure of bone. Individuals who are affected by osteoporosis may be subject to serious fractures and it is estimated that annually approximately 1.5 million fractures can be attributed to this disease [1]. The disease is categorized as the direct side effect of increased bone porosity and bone loss and is directly linked to estrogen deprivation [2]. Animal models are often used to make initial conclusions about the effects of the disease or pharmacological treatments. In this study, sheep were chosen as a representative animal model due to their similar metabolic characteristics to that of a human. Like most animals, the ovine does not undergo a natural menopause and an ovariectomy was necessary to replicate the condition. The study objective was to quantify compact bone density present in ovine at three months post ovariectomy.

The study included 112 ovine separated into different treatment groups. The treatment groups were separated into 4 groups of 28 based on season of surgery: autumn, winter, spring, and summer. Each seasonal group was further divided into 2 groups of 14; the first group underwent an ovariectomy; and the second group underwent a sham surgery, in which the ovaries were visualized and handled but left in the abdomen. One group was sacrificed 3 months post operatively and the other group was sacrificed at 12 months post operatively. This study specifically looks at ewe sacrificed at 3 months. The radius from each sheep was cut into the anatomical sectors: cranial, caudal, craniolateral, craniomedial, caudomedial, and caudolateral. Each anatomical sector was turned into a

microradiograph for analysis. Densitometry was performed to determine the density of each specimen using the estimated thickness of aluminum (ETA) as the key. Statistical analysis assessed the resulting data to understand the effects of treatment, season of sacrifice, season of surgery, and anatomical sector by comparing both mean ETA and standard deviation ETA to understand changes in bone density.

The results revealed significant differences between the ovariectomy and sham groups as well as variation within season of surgery and season of sacrifice in both groups. Anatomical sector showed no significant variation. The differences in the thickness of aluminum seen in the sheep that underwent a sham operation can be attributed to the presence of estrogen. The sheep that underwent an ovariectomy showed differences in the estimated thickness of aluminum that can be attributed to other seasonal characteristics including the influence of Vitamin D. The results and conclusions within this study can be used to influence bone material characteristics and bone loss test protocols in future osteoporosis and estrogen depletion studies.

Keywords: Estrogen Depletion, Bone Remodeling, Osteoporosis, Ovariectomy, OVX, Ewe

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1. INTRODUCTION

1.1 Purpose

Osteoporosis greatly affects elderly postmenopausal women, and often men. The disease is categorized as the direct side effect of increased bone porosity and bone loss. Slowly osteoporosis has shown an even larger financial cost to society due to the increased life expectancy that comes with improved medical technology and research [2]. As the average life expectancy of women and men increases, the treatment of osteoporosis produces an increased cost to society due to medical costs. This cost totals approximately \$5-10 billion in healthcare with the potential to increase to an annual cost of \$60 billion in 30 years [1]. Individuals who are affected by osteoporosis may be subject to serious fractures, annually approximately 1.5 million fractures may be attributed to the disease [1]. From these fractures come further detriments to the body induced by the side effects of the fractures, including death, due to immobility causing blood clots. In elderly patients, the mortality rate 1 year after a hip fracture can be between 14.7% and 24.3% [3].

The condition itself was first understood in the mid 1940's but has only recently been well characterized when methods for accurate bone mass measurements were developed in the 1970's, but is still not well understood [1]. Research has been done in human epidemiology studies producing probabilities of lifetime risk of fracture as high as 16% for a 50 year old woman [1]. By studying the condition in the ovine with induced osteopenia and osteoporosis characteristics, knowledge of osteoporosis can be applied to the human condition. In this study, sheep have undergone an ovariectomy to induce estrogen depletion to further understand this condition. The goal is to differentiate bone

architectural changes known to be characteristic of estrogen depletion from material changes that are independent of changes in porosity. This knowledge could aid in the development of possible treatments or prevention measures of osteoporosis.

1.2 Skeletal Biomechanics

Osteoporosis affects the skeleton through the direct effect of the disease on the function and structure of bone. The human skeleton includes 206 bones, each of which is composed of a similar structure. The human skeleton provides the protection and framework necessary to support the human body.

1.2.1 General Structure and Composition

The human skeletal system is a functional unit within the human body that provides support, protection, movement, electrolyte balance, acid-base balance, calcium storage, and blood formation. The system is composed of bone, cartilage, ligaments and tendons, each with its own specialized purpose to support the basic structure of the body. Bone acts as the basic structure of the human body, providing support, protection, bone marrow production and mineral storage, among other functions [4]. Cartilage acts as a separating cushion within diarthrodial joints preventing bone-to-bone contact and to provide nearly frictionless motion for our joints. Ligaments connect bone to bone and tendons act to connect muscle to bone. Ligaments and tendons allow for movement of the body and also prevent unwanted movement of the joints. Bone is composed of osseous tissue. Osseous tissue is the calcified tissue that provides bone with its hard structure and allows it to support the human frame [4].

There are several different types of bones in the human body: long bones, short bones, flat bones, and irregular bones. Examples of long bones include the tibia, femur,

and phalanges, short bones include the capitate and talus, flat bones include the scapula and sternum, and irregular bones include vertebra and sphenoid. Long bones, including the femur, are generally longer than they are wide. They act as levers for which the ligaments and tendons are able to apply forces allowing the body to move as intended. The shape of the humerus, as seen in Figure 1, can be broken down into two specific areas, the epiphysis and diaphysis. The epiphysis is located at either end of the bone and provides a larger amount of surface area for ligaments and tendons to attach. The diaphysis is located down the shaft of the bone between the epiphyses. The epiphysis and diaphysis are separated by the epiphyseal line, the location of prenatal, postnatal, and adolescent growth, commonly known as the growth plate [4].

Figure 1 Key structures characteristic of an adult human long bone [5].

All bones include two basic types of bone: compact and cancellous (spongy) bone. Compact bone is composed of dense osseous tissue, providing strength in the bone [6]. Generally, the compact tissue is located throughout the diaphysis of the bone with a

porosity of approximately 5%-10%, Figure 1 [6]. Cancellous bone is composed of osseous tissue that is more porous, approximately 75%-95% [6]. This tissue is often located at the ends of the bone in the epiphyses and houses bone marrow and provides a large surface area ideal for ion exchange. The outside surface of bone is covered by the periosteum, the outer layer of which is composed of collagen (protein) and an inner osteogenic layer, the location of bone forming cells. The inner surface of bone is lined with the endosteum [4]. Each layer of bone is important to the growth and maintenance of bone structure.

1.2.2 Bone Matrix Composition

The bone matrix is a composite of both organic and inorganic materials. The organic components include collagen and other various proteins, acting as the fibers. The inorganic material is composed of mostly calcium hydroxyapatite [4]. Collagen plays a critical role in the function and structure of bone tissue. In total there are 28 types of collagen currently discovered, type I being the most prominent. In addition to collagen, the organic portion of the bone matrix is composed of noncollagenous matrix proteins (NCP's), including osteocalcin. The NCP's can be used to measure bone formation and collagen can be used to measure bone resorption through their presence in urine or serum. Another NCP found in the bone matrix is fibronectin, accumulating at the initial sites of osteogenesis, the initial stages of bone formation and resorption [7]. These larger proteins found within the bone matrix can be measured and used in the diagnosis and treatment of osteoporosis.

Within the bone matrix there are five main types of bone cells. These cell types include: osteogenic (osteoprogenitor) cells, osteoblasts, osteocytes, osteoclasts, and bone

lining cells. Osteogenic cells are stem cells developed from embryonic mesenchymal cells and hematopoietic progenitor cells. These are the basic cells that have the opportunity to develop into most other types of bone cells. Osteogenic cells are located in the endostium just below the periosteum and in bone marrow. Osteoblasts are bone-forming cells, created to synthesize the unmineralized bone matrix. Generally the cells are cuboidal and are seen as a monolayer below the endosteum making a sheet. Osteocytes are former osteoblasts remaining in the bone matrix after mineral deposition. They are located in lacunae and are connected by canaliculi. Osteocytes help maintain the appropriate balance of bone density and blood concentrations of calcium and phosphate. The cells are able to act as strain sensors to regulate bone remodeling [4]. In addition to maintaining bone density, the cells sense developing microcracks and respond to hormonal changes, including changes in estrogen levels [8]. Osteoclasts are bone-dissolving cells. These cells are much larger than the three previous cell types, and are often multi-nucleated. Bone lining cells are osteoblasts that have become inactive. They function as a barrier along the bone surface and maintain communication with osteocytes. They also have receptors for the parathyroid hormones and estrogen [6]. These five types of cells work together to perform the processes of bone formation and resorption.

1.3 Bone Modeling and Remodeling

During normal service, bone constantly undergoes microcracking, which needs to be repaired to prevent serious fracture. If microcracks are not repaired, the bone will continue to crack and the microcracks have the potential to develop into full fractures. Bone remodeling is the process through which these microcracks are repaired. Remodeling is similar to bone modeling with a few significant differences. In bone

modeling, osteoclast and osteoblast cells are working in different areas and certain cells are active in specific locations, while in remodeling the osteoclasts and osteoblasts are working together as a single unit. During modeling, changes in bone size and shape are often apparent while the opposite is seen in remodeling, size and shape are not affected [6]. At the location of the damage, microcracks in bone, bone cells work together to first remove and then replace the damaged tissue, Figure 2. This process has a specific beginning and ending as opposed to bone modeling, which continues for an extended period of time. After the initiation of the process, the osteoclasts work to remove the damaged bone to prepare for bone replacement by the osteoblasts [6].

Figure 2 The remodeling process in a adult human bone [9].

1.3.1 Remodeling: ARF

Diving deeper into the bone remodeling process gives view to the basic multicellular unit (BMU). A BMU is composed of teams of osteoclasts and osteoblasts working together to replace damaged tissue, in situations of intense stress, as well as respond to hormonal changes including estrogen depletion. The cycle of a BMU is based on three basic stages: activation, resorption, and formation, abbreviated ARF [6].

During activation, the process is initiated by a mechanical or chemical signal [6]. The signal is believed to be one of the many different hormones in the body, including estrogen. This signal brings about the formation of osteoclasts through the fusion of monocytes, which then begin to remove bone. Second in the process is resorption; the osteoclasts continue to resorb bone in preparation for new bone to be formed. The resorption process creates a ditch on the surface or a tunnel through the matrix of bone. The osteoclast cells move at approximately 40um per day and the process takes approximately three weeks to reach the maximum resorbed depth or diameter. Following resorption, formation begins. During formation osteoblasts are differentiated from mesenchymal cells and are dispersed to form new tissue. The formation process as a whole is a much slower process than resorption; the process takes approximately 3 months [6].

1.3.2 Cellular Events in Remodeling

Through the stages of ARF, certain cellular processes are initiated and maintained through cellular migration, mitosis, and differentiation. The cellular processes are controlled and maintained through hormones or chemicals, including estrogen [6]. Specific cellular pathways can be seen in Figure 3.

Figure 3 The stages of bone remodeling, including the development of osteoclasts and osteoblasts. Factors listed in red are factors that have been confirmed or are being researched in clinical studies. Factors in green are potential factors currently being researched in vitro or in animals [10].

Each step through the ARF process is initiated by several factors [10]. There are three known forms of communication between osteoclasts (resorption) and osteoblasts (formation) that initiate the resorption and formation processes. The first is through direct contact. Direct contact allows ligands to bind to receptors within the membranes of the cells to initiate the cell signaling process, specific ligands include the receptor activator of nuclear factor kappa-B (RANK) and the receptor activator of nuclear factor kappa-B ligand (RANKL). RANKL is a cytokine that functions as a key factor in osteoclast activation and differentiation. RANK is the membrane protein expressed on the surface of osteoclasts. Upon binding of RANK to RANKL, the osteoclast initiates resorption [11]. The second is through the formation of gap junctions. Through the gap junctions, small water soluble molecules are passed between the two types of cells [12]. The gap junctions are composed of 6 proteins and are able to pass small molecules up to 1 kDa between osteoblasts, or between osteoblasts and osteocytes. Not much is known

about the factors passed through these channels, but the communication between cells has been proven to be an important component of resorption [13]. The third method is through diffusible paracrine factors, including growth factors, cytokines, chemokines, and additional small molecules, including estrogen [12].

Living osteocytes secrete the transforming growth factor β (TGF- β), which is known to inhibit osteoclastogenesis and resorption by osteoclasts [14]. It is also known that estrogen, a hormone, prevents osteocyte apoptosis. With normal levels of estrogen, bones continue to follow the typical bone remodeling process, maintaining homeostasis with appropriate levels of resorption and formation. However during estrogen deprivation, as present in menopause, the total amount of osteocyte apoptosis is increased, which leads to an increase in active osteoclasts. Estrogen increases the levels of TGF- β , a transforming growth factor that acts as an inhibitor of resorption by the osteoclasts [14]. If estrogen levels are not at normal healthy levels, this process demonstrates an increase in bone resorption while formation remains constant. It is already known, the resorption process is a much quicker process than bone formation [6].

1.3.3 Quantitative Analysis of Bone Remodeling

In past years, the study of bone remodeling has used conventional techniques to gather information. By being forced to rely on histological analysis to provide an accurate assessment of bone remodeling, methods of using architectural and cellular patterns have been used to identify resorption and remodeling [15]. These methods can also be used to identify the bone microarchitecture.

Frost was one of the first to demonstrate in bone how histologic sections could be analyzed to quantify the characteristics of bone remodeling, serving as the foundation to

future studies [6]. This process was first used on the human rib and since then has been used on other human and other animal models. In this process, a model is labeled twice with tetracycline or another fluorochrome stain to show mineralizing bone, the first given 7-14 days before the second label. The stain is used to determine bone remodeling characteristics and is best observed under epifluorescent light [6].

Bone density can be quantified in several different ways through invasive and non-invasive procedures. A specific procedure to measure bone mineral density (BMD) to quantify density is through a micro-computed tomography (μ CT). A μ CT has the ability to generate high-resolution images of cortical and cancellous bone in both human and animal models. Other options in addition to a μ CT include dual energy X-ray absorptiometry (DXA) and quantitative computed tomography (QCT) [16]. More invasive options include microradiography; a cross sectional representation of the specimen is ground to approximately 100 μ m thick, a microradiograph is taken and subsequently imaged, and then further micro-densitometry analysis performed using computer software.

1.4 Estrogen and Bone

Estrogen has been directly linked to bone metabolism both in women and men through many in depth studies [8]. A common treatment in post-menopausal women is the replacement of the estrogen hormone in several different forms. With estrogen replacement treatments, a reduction in the basic serum markers present during bone resorption can be noted [8]. The results of these treatments also show lower cell counts of osteoclasts and osteoblasts. The low counts of osteoclasts depends on the number of hematopoietic osteoclast progenitors, and the activity of osteoblast progenitors, in

addition to the activities of those cells and their ability to support bone resorption and formation [17]. A lower level of osteoclasts supports the conclusion that estrogen treatments reduce the amount of resorption occurring in the bone. This helps to maintain the homeostasis between resorption and formation, by allowing the amount of resorption and formation to better represent levels seen in healthy individuals.

Similar to menopause, an oophorectomy leads to an increase in the total number of osteoclasts. By removing the ovaries, a large producer of estrogen, estrogen levels within the body are significantly decreased. This leads to an increase in bone resorption and an increase in bone formation. The cycle time required for bone formation is longer than the cycle time of resorption, but because the resorption cycle time is shorter it dominates when estrogen levels are lower, leading to a net decrease in bone density [8]. Although it is known estrogen depletion leads to a decrease in bone mineral density (BMD), additional research needs to be conducted to understand exactly how and why estrogen inhibits bone resorption and in turn is a large factor in the regulation of formation. It is believed osteocytes are the initial target of estrogen treatments. Estrogen directly influences osteoblasts, osteoclasts, and osteocytes; osteocytes being the regulators of bone homeostasis, Figure 4. Estrogen causes osteocytes to inhibit the activation of bone remodeling. The hormone causes osteoblasts to also undergo a reduction in several mechanisms regulating the maintenance of bone formation. Estrogen influences osteoclasts to cause a reduction in bone resorption. Individually each of these cells also depend on each other to regulate different aspects of bone remodeling [8]. Currently many research groups are conducting studies to better understand the effects of estrogen on its ability to decrease bone resorption and the activation of bone remodeling.

Figure 4 A breakdown of how estrogen influences the different types of bone cells [8].

1.5 Osteoporosis

1.5.1 General Information

Osteoporosis is a systemic condition characterized by a low bone mineral density (BMD). Low levels of BMD can be the result of a micro-architectural deterioration of bone tissue or a defect in mineralization. These symptoms are associated with bone fragility and a severely increased fracture risk [18]. The condition occurs in post-menopausal women, and often in the elderly. In people over the age of 55, 1 in 2 women will have a severe fracture due to low bone density and 1 in 4 men will have an equivalent fracture [18]. Not only may individuals diagnosed with the condition endure fractures, but the fractures can lead to other debilitating conditions including blood clots due to immobility caused by the fracture. Although the initial fracture may not be serious, the condition can lead to much more serious conditions.

Figure 5 Left: An X-Ray of a healthy woman's pelvis [19], Right: An X-Ray of a woman diagnosed with osteoporosis post menopause [20]. Note the decrease in density in the bone from left to right.

Bone mineral density peaks when an individual is in their 30's, declines in women as menopause approaches, and the decline accelerates immediately post menopause. In total, following menopause approximately one third of peak BMD is lost, Figure 5. If the decline in BMD is not treated, the likelihood of developing osteoporosis increases significantly. With low BMD, fracture can be caused by minimal impact, such as bumping into a table, or a short trip and fall [21]. Osteoporosis is defined as a BMD less than or equal to 2.5 standard deviations below the mean BMD for adults age 25-30 [22]. If an individual has a BMD that is within 1 and 2.5 standard deviations below the mean BMD of a healthy adult age 25-30, they are diagnosed with osteopenia, a precursor to osteoporosis. The T-score is a value used by physicians to compare an individual's bone density to the optimal bone density based on age and gender which is used in diagnosis [21]. The T-scores is compared to the fracture risk and BMD in Figure 6. As the total BMD decreases below the mean, the fracture risk increases at a T-score below 2.5.

Figure 6 Average total hip bone mineral density levels at different ages. The graph is separated into normal, low, and osteoporotic levels demonstrated through shading [21].

1.5.2 Treatment

When treating osteoporosis the main goal is to reduce the threat of death and injury by reducing the risk of a serious fracture, as it is not possible to cure the condition. The goal is to identify patients who will be at an increased risk based on the levels of BMD before they reach a T-score at an osteopenic or osteoporotic level. Post-menopausal women are already at an increased risk due to estrogen depletion [21].

Fracture risk can be grouped into three categories based on the levels of risk and required treatment: low, moderate and high. Those with higher BMD and T-score levels are considered to be low risk and will not require present treatment because the bone mineral density is near normal levels. Those with a lower BMD as compared to the mean will be considered to have moderate or high risk. To treat those with moderate risk, a physician should consider clinical risks to determine if there is a need for treatment or if the individual is at an increased risk for future fractures, such as participation in a contact

sport or old age. Those who are considered to have a high risk for injury should be considered for pharmacologic treatment. This group of individuals have approximately a 20% probability of sustaining a major fracture in the next 10 years [23]. Physicians must consider both BMD and physical risk factors when assigning a patient to a particular group. Often the algorithm in Figure 7 is used by physicians to determine an appropriate treatment for the at-risk patient.

Figure 7 A typical path a physician may take in patients in menopause or post menopause to determine the most appropriate course of action to prevent further decrease in BMD [21].

Many patients are asymptomatic until they get their first fracture, with the exception of vertebral fractures. However there are several adequate ways to aid in prevention, before a patient is even at risk. An adequate intake of vitamin D and calcium has been proven to improve the T-score, along with a general awareness for their own

overall health, Figure 8 [21]. There are also several pharmacologic methods of intervention including estrogen and progesterone treatments, selective estrogen-receptor modulation, and several additional therapies. Estrogen and progesterone treatments are only approved for prevention of osteoporosis in women with post-menopausal symptoms [22]. This treatment also has the benefit of minimizing hot flashes, a common symptom of menopause, however it also has the potential to be carcinogenic. Another treatment option is a selective estrogen – receptor modulator (SERM). SERM's are able to bind to the estrogen receptor and produce an alternative action within the cell. These are able to mimic the effect of estrogen without the likelihood of bad side effects, acting in the same fashion as estrogen and reducing the activation of osteoclasts. An example of a SERM is Raloxifene. This however also has poor side effects; it has the potential to increase the chance of blood clots, which could lead to heart attack or stroke. Additional treatment options are available, including bisphosphonates, which are the most common [22], [24].

Figure 8 Fracture rates per 1000 people/year in elderly women. The dark bar demonstrates women treated with vitamin D and calcium and the light bar demonstrates women treated with a placebo [22].

1.6 Animal Models

As with any study in the medical field, animals are often used to make initial conclusions about the effects of a disease or pharmacological treatments. The studies are used to isolate a specific treatment and perform statistical analysis to eventually provide results to lead to further research or drugs to help humans who are affected by the condition [25]. In this specific study, an animal model is needed to understand how estrogen depletion affects the basic model. This understanding can then be applied to human treatments and aid in the understanding of osteoporosis in humans.

There are many animal models available to choose from when studying estrogen and osteoporosis, however from previous studies, ovine are one of the better models for a study requiring a large number of samples conducted over a long term period [26]. Other possible animal models include minipigs, ferrets, guinea pigs, rats, rabbits, primates, dogs, and cats, each with its own unique benefits and detriments. Similar studies have used ovariectomized rats as a consistent model for osteoporosis [25]. For 12 months after an ovariectomy, rats cancellous bone mimics post menopausal bone in women. However, after the 12-month period rats tend to show higher values of BMD, bone area, and bone weight as compared to average human values. Also an absence of impaired osteoblast function during the late stages of estrogen deficiency is present in rats, a phenomenon not present in humans [25]. Based on these conclusions, a rat model was determined to be too inconsistent to fit the needs of the study. For the study, an animal model with bone and metabolic characteristics similar to humans as well as being able to fulfill the time length requirement of the study was required.

In this study, skeletally mature ovine were chosen as the animal model. Most

importantly, the metabolic rate of an ovine is similar to humans, based on O_2 consumption per gram body weight, in sheep the metabolic rate is .22 and in humans it is .21 [27]. Ovine are also docile, compliant, and there is not a significant emotional attachment from humans, as there is with dogs and cats. From a chemical perspective, the regulation of hormones is similar to that of women [25]. Additionally their bone composition is similar to humans, composed of a woven and lamellar bone structure, with the presence of haversian remodeling [26]. During a study, if necessary it is also possible to take blood and urine samples to determine levels of relevant proteins or identifying factors. From a financial perspective, they are affordable and are available in large quantities [25]. Despite the benefits, there are some limitations of using mature sheep as a model. Sheep do not have a clear-cut menopause period characterized by accelerated bone loss and decrease in BMD as is present in women around the age of 50. The completion of an ovariectomy in ovine is required to mimic menopause and induce osteopenia, post ovariectomy ovine have similar estrogen and bone mineral density levels to women. On a chemical level, an ovine's phosphorous metabolism is different, and the excretion of phosphate in urine is lower than humans [26]. Despite the limitations, based on their characteristics, they are one of the best animal models for this type of study.

When using ovine as an animal model for this type of study, it is important to maintain appropriate vitamin D and calcium levels. To achieve the appropriate vitamin D levels, animals must be exposed to sunlight. The amount of sunlight an animal is exposed to is dependent on the season, daytime length, and amount of time in the sun, essentially UV exposure. Several studies have provided evidence that seasonal variation affects BMD of the animal [25]. This is one of the factors studied in the analysis of this

study.

1.7 Study Objectives

The purpose of this study was to quantify compact bone density present in sheep at 3 months post ovariectomy. Measurements were taken from cortical bone in the radius. Analysis was completed for each sheep to consider the impact of treatment, season of surgery, season of sacrifice, and sector to the mean equivalent thickness of aluminum (ETA). The thickness of aluminum was used to represent the bone density of the animal specimen in density measurements. Aluminum has a similar atomic number to hydroxyapatite, making it an effective way to measure bone density [28]. Anatomical sector is defined as the different anatomical sections of the bone: craniomedial, cranial, cranolateral, caudomedial, caudal, and caudolateral.

Previous research has provided conclusions based upon the study of skeletally mature sheep after undergoing an ovariectomy. Research has been published to provide a connection between bone remodeling and season [25]. This study is a continuation of a previous study looking at the density based on sector and season [28]. Based on the results of the previous study, [28], it is expected the current study will provide insight into the expected differences in density between sector, season, and treatment. There has been little research looking further into bone material density with respect to the interaction between season of sacrifice and the anatomical location within the bone. It is expected that there will be a significant interaction between the season and anatomical location, and additionally there will be a difference in the results of the ovine that underwent an ovariectomy and those who underwent a sham operation. The results of this study will aid in opening the door to additional research by expanding the definition

of the animal model, and by looking at changes in the anatomic distribution of the parameters in the OVX group as compared to the control.

2. MATERIALS AND METHODS

2.1 Animal Preparation

As part of a larger study approved by the Colorado State University Animal Care and Use Committee, this study utilized 112 female ewes. The ewes were commercial culls purchased at auction in southern and eastern Colorado at the beginning of the study. Each was greater than 5 years old and was kept at Colorado State University, Ft. Collins, Colorado. The surgeries were performed at the College of Veterinary Medicine and Biomedical Sciences at Colorado State University. They were kept in dry lots at 41° latitude and 1,500m above sea level and fed a grass-alfalfa mixture. The 112 ovine were separated into different treatment groups. Initially, they were separated into 4 groups of 28 based on season of surgery: autumn, winter, spring, and summer. Each seasonal group was further divided into 2 groups of 14; the first group underwent an ovariectomy (OVX) and the second group a sham surgery, in which the ovaries were visualized and handled but left in the abdomen. The summer group had their surgeries performed in August, autumn in November, winter in February, and spring in May. Post surgeries, the groups of 14 were further separated into groups of 7 ewes. One group was sacrificed 3 months postoperatively and the other group was sacrificed at 12 months postoperatively.

2.2 Ewe Specimen Preparation

Once sacrificed using an intravenous overdose of a barbiturate anesthesia, both the right and left radius and ulna were removed from each ewe. In sheep the radius and ulna are functionally fused early in life and all samples used in this study were from the radius. The bones were removed and stored in a saline soaked towel and kept at -20° Celsius. The samples were transferred and prepared for analysis at Henry Ford Hospital.

From the left radius, the epiphyses were removed with a band saw (Model 5212, Hobart Corporation, Troy, OH) to leave only 50mm of the diaphysis in the long bones. The diaphysis was further cut using the Exakt cutting-grinding system (Exakt Corporation, Oklahoma City, OK). The radius was divided into 6 sectors including cranial, caudal, craniolateral, craniomedial, caudomedial, and caudolateral; the sections can be seen in Figure 9. Up to 25 beams were cut from each left radius with the dimensions 1.75x1.75x19mm; a single beam from each sector was chosen at random to act as a representative sample from each location. Non-destructive dynamic mechanical testing was performed on each of the beams. After testing, an 8mm section was cut for drying and ashing to determine the bulk density. A 150µm thick section was also cut from the beam to be used in histomorphometric analysis. The remaining portion of the beam was frozen for analysis at a later date.

Figure 9 Anatomical separation of the radius and ulna. The cranial sector is located in the upper right and the lateral sectors are located in the top left side of the figure [29].

The 150µm sections were further ground by hand, using fine grit sand paper, to a thickness of 100µm. Microradiographs of each 100µm section were taken using 2506AGHD 2.5x2.5x0.06 High Definition Photo Emulsion Plates and an HP Cabinet Faxitron (HTA Enterprises, Microtome Technology Product, San Jose, CA). This process was performed at 25kV for 20 minutes at 3mA. The location of each sector on

each the microradiograph can be seen in Figure 10. Each plate contains all 6 sectors for 2 separate ewes in addition to a Reynolds Aluminum Foil stepwedge down the center.

Aluminum was used to determine the density of the bone based on the similarities in the atomic number of aluminum and hydroxyapatite [28]. Using the Reynolds Aluminum Foil stepwedge, it was possible to determine the density of each specimen by comparing the intensity of the aluminum foil stepwedge to the image intensity of the bone specimen. The stepwedge was created by layering .02mm pieces of aluminum foil on top of each other to create steps with a known value, seen down the center of Figure 10.

Figure 10: Microradiograph setup. Ewe 1 is on the left and ewe 2 is on the right. Sectors begin at the top with cranial and end with the caudolateral section.

2.3 Specimen Imaging

The samples prepared at Henry Ford Hospital were sent to Cal Poly where they were imaged at 100x using an Olympus BX-41 Microscope and an attached Retiga EXi Q color camera (QImaging, Surrey, BC, Canada). Each anatomical sector on the microradiograph was imaged at 100x using the attached camera, QCapture Pro (QImaging). In this study, all ewes sacrificed at 3 months and ewes that underwent a

sham surgery sacrificed at 12 months were imaged. Bone samples of ewes who underwent an ovariectomy and were sacrificed at 12 months were imaged in a previous study [28].

During the imaging process, the appropriate light intensity was selected to be used for all of the 6 sectors and remained constant between each sector. When viewed through the microscope, the sample must be bright enough to be visible, however not so intense the bone characteristics were not visible. It was important to ensure each bone specimen was visible both through the microscope as well as through the imaging camera and software. When imaging the specimens, each anatomical sector was broken into 4 quadrants: northeast, northwest, southeast, and southwest. Each quadrant was imaged individually at 100x. An example of the quadrant breakdown is seen in Figure 11. In total, this includes 24 separate images per ewe.

Figure 11: The break down of an anatomical sector imaged at 40x from a previous study [29]. Each of the 4 quadrants were imaged at 100x and analyzed in the current study.

Using the same intensity as the bone specimens, the aluminum stepwedge was

imaged at a 40x magnification with the camera and saved. The aluminum stepwedge is composed of 9 steps of different aluminum layers, including a blank microradiograph with a zero thickness image, beginning with 0.0mm of aluminum increasing by 0.02mm with each step, for a total of 8 steps, Figure 12. Each step was only imaged a single time.

Figure 12: The stepwedge for ewe 93, an example of the aluminum stepwedge, showing the increase thickness. From left to right, top to bottom, the stepwedge demonstrates an increase from 0.0mm to 0.02mm, 0.04mm, 0.06mm, 0.08mm, 0.1mm, 0.12mm and 0.14mm.

2.4 Densitometry Analysis

To quantify bone density, the intensity of each bone specimen was compared to the intensity of its corresponding aluminum stepwedge. Each image, including both sectors and stepwedges were loaded into ImageJ (Wayne Rashband (NIH)) and analyzed. Using this software tool, it was possible to produce a numerical pixel value corresponding to the intensity. Aluminum is often used because it is repeatable in its makeup and X-ray attenuation properties. It is a consistent standard to which a bone section of known thickness can be compared, therefore it is possible to calculate a density for each specific bone specimen. The numerical values for each specimen can be compared to the numerical values of the aluminum stepwedge, thereby producing a density value. Typically thicker more dense materials appear lighter, while thinner less dense materials appear darker.

Each step in the stepwedge, correlates with a thickness increase of 0.02mm.

Using the histogram feature in ImageJ (Wayne Rashband (NIH)), it was possible to create a table of data, which includes the number of pixels at every pixel density from 0 to 255. The mean pixel intensity was determined for each level in the step wedge to serve as the key. By graphing the aluminum thickness and the mean pixel intensity it is possible to produce a 4-parameter sigmoid curve (Equation 1) in Sigma Plot 11.0 (Systat Software, Inc.). In the equation 1, y_0 represents the maximum asymptote, a represents the difference between the maximum and minimum asymptotes, and $(x-x_0)/b$ represents the steepness of the curve. The results of the 4-parameter sigmoid curve provide the key parameters necessary to determine the equivalent thickness of aluminum (ETA) of each pixel to determine the density of each bone sample, based on the stepwedge created using aluminum. The distribution of the pixel counts was used to determine the ETA of each specimen using the parameters of the stepwedge, using the Stepwedge Template and the Quantitative Densitometry Template. Based on the distribution of the stepwedge pixels, it is necessary to use the complex curve to achieve an accurate fit while also making the fewest assumptions.

$$y = y_0 + \frac{a}{1 + e^{-\left(\frac{x-x_0}{b}\right)}} \quad (\text{Eq. 1})$$

With the parameters determined by the sigmoid curve, it was possible to determine the ETA of each specimen. In equation 1, the ETA value is represented as the x variable. Again, the histogram feature in ImageJ (Wayne Rashband (NIH)) was used to determine the density in each quadrant of a given specimen. From the histogram, the pixel count at each pixel density was converted to ETA using the parameters calculated from the corresponding stepwedge, and pixel count is represented as the y value. Also

included in this calculation was the porosity of each sector to represent the proportion of pixels in the image representing non bone pixels [28]. The porosity was determined in a previous study by counting all points that were not considered bone and dividing that number by 144, the number of possible points. Beginning with the lowest ETA pixel values, the ETA data values were deleted until the value represented 1 minus the porosity. These values were determined for each sample and their corresponding stepwedge [28].

2.5 Statistical Analysis

The densitometry results for the ewe sacrificed 3 months post-operatively were analyzed using Microsoft Excel Version 14.2.5 (Microsoft Corporation) and Sigma Plot 11.0 (Systat Software, Inc.). The images and data collected for the group of ewe sacrificed 12 months post-operatively were saved and will be analyzed in a future study as indicated in Future Work, Section 4.2. A statistical analysis was performed to look for significance in the main effects and interactions between the treatment, season of surgery, season of sacrifice, and anatomical sector comparing the data groups mean ETA and standard deviation of ETA, ETA chosen to represent bone density in the samples and standard deviation used to determine the differences in the variation in ETA in the comparisons.

2.5.1 2-Way ANOVA (Analysis of Variance)

Initially the statistical software Sigma Plot 11.0 (Systat Software, Inc.) was used to perform a 2-way ANOVA. The 2-way ANOVA was used to compare the effects of season of sacrifice and sector considering mean ETA and standard deviation in the ETA for ewes who underwent a sham surgery. This analysis allowed for the creation of a baseline to allow further comparison of the effects of season of surgery and sector. These

results had the potential to show normal differences in densitometry from sector to sector in healthy animals. The pairwise comparisons in the 2-way ANOVA were performed using a post-hoc Fisher Least Significant Difference (LSD) test.

When performing a 2-way ANOVA, it was necessary to make assumptions required for a 2-way ANOVA. These assumptions include equal variance and normality. If these assumptions are met, the strength of the comparisons produced by the ANOVA analysis increases.

2.5.2 3-Way ANOVA

Using Sigma Plot 11.0 (Systat Software, Inc.), 4 separate 3-way ANOVA analyses were performed.

1. Season of sacrifice, sector, and treatment with mean ETA
2. Season of sacrifice, sector, and treatment with standard deviation ETA
3. Season of surgery, sector, and treatment with mean ETA
4. Season of surgery, sector, and treatment with standard deviation ETA

The comparison of the data with respect to season of sacrifice and season of surgery had the potential to show differences as well as interactions. Expected differences could be due to the remodeling which occurred during the 3 months between surgery and sacrifice. The pairwise comparisons in the 3 way ANOVAe were made using post-hoc Fisher LSD tests.

Equal variance was checked through the statistical software or through a plot of residuals vs. predicted values. In this plot, the spread of the data should be regular; a large or small spread signifies a violation of equal variance. Normality of the data can be checked through a normal plot of the data. In this graph the data should follow a normal

Gaussian curve. In this specific study, the normality of each combination of groups was also examined.

2.5.3 Frequency Distributions

In addition to the ANOVA analysis performed on the data, a Gaussian distribution was developed from the raw data to check for the degree of normality. Using the data output from ImageJ (Wayne Rashband (NIH)), the bone pixel values and ETAs were graphed to create frequency curves. The frequency distributions were created by graphing the ETA on the x-axis and pixel frequency on the y-axis. The ETA values were grouped into 20 bins of equal size and the following graphs were created.

1. Graph of all data: all sectors and all sheep
2. Graph of OVX and Sham: 2 separate curves
3. Graph of all Sectors: single graph with 6 separate curves: OVX and control
4. Graph of each Sector: 6 separate graphs, 2 curves per graph: OVX and control

Based on the distribution of the graphs, it was also possible to determine how the ETA values were distributed by pixel value based on the sector and treatment. The location of the bulk of the ETA and corresponding pixel count described the density of the specific sector and treatment as a whole. When the graphs were analyzed it was important to look at the differences and similarities between the sector and treatment as seen in the curves.

3. RESULTS

3.1 Densitometry

The study was designed to examine the effect of treatment, season of surgery, season of sacrifice, and anatomical sector on sector mean ETA. Using the statistical techniques described in Section 2, the interactions were analyzed through 2-way ANOVAs and several 3-way ANOVAs using Sigma Plot 11.0 (Systat Software, Inc.).

The tests performed include:

2-Way ANOVA

- Sector, Season of Sacrifice, mean ETA
- Sector, Season of Sacrifice, standard deviation ETA

3-Way ANOVA

- Sector, Treatment, Season of Sacrifice, mean ETA
- Sector, Treatment, Season of Sacrifice, standard deviation ETA
- Sector, Treatment, Season of Surgery, mean ETA
- Sector, Treatment, Season of Surgery, standard deviation ETA

Constant values determined from the 4-parameter sigmoid curve calculated the mean ETA for each. The mean ETA was determined through a pixel count based on the intensity. The mean ETA was determined for all ewe sacrificed at 3 months for OVX and sham, as well as, the sham surgery group sacrificed at 12 months. The mean ETA for ewe sacrificed at 12 months with an ovariectomy was determined in a previous study [28]. In this study, statistical analysis was performed only to compare sheep sacrificed at 3 months.

The data prior to the statistical analysis, as seen in Table 1, shows a calculated value of the mean ETA for each group before any possible interactions have been determined. Based on these calculated values, variation is noted in the mean ETA with respect to treatment, season of surgery or sacrifice, and anatomical sector.

Table 1 Densitometry values (ETA) for sheep sacrificed at 3 months

Densitometry (ETA) (mm)		
Treatment		
Group	Mean	Standard Deviation
OVX	0.054	0.022
Sham	0.071	0.026
Season of surgery		
Autumn	0.076	0.027
Winter	0.055	0.021
Spring	0.073	0.014
Summer	0.044	0.023
Season of Sacrifice		
Autumn	0.044	0.023
Winter	0.076	0.023
Spring	0.055	0.021
Summer	0.074	0.014
Anatomical Sector		
Craniomedial	0.066	0.025
Cranial	0.062	0.025
Cranolateral	0.063	0.026
Caudomedial	0.062	0.025
Caudal	0.059	0.023
Caudolateral	0.063	0.027

3.2 2-Way ANOVA

The 2-way ANOVA analysis, using Sigma Plot 11.0 (Systat Software, Inc.) compared sector and season of sacrifice to both mean ETA and standard deviation ETA for the sham treatment group. The results of this statistical test established the baseline to show the statistical differences and interactions in a sheep with normal mean and standard deviation ETA levels.

The 2-way ANOVA examining the effects of sector and season of sacrifice on mean ETA provided similar results to 2 way ANOVA comparing sector, season of sacrifice and standard deviation ETA, Table 2. The result of the analyses led to the

conclusion that there is no demonstrable significant difference in mean ETA or standard deviation ETA in the interaction between sector and season of sacrifice. However, there is evidence of a difference in the mean ETA as well as the standard deviation ETA within the different seasons of sacrifice. Essentially within the control group, the sector does not affect the mean/standard deviation ETA.

Table 2 2-Way ANOVA statistical analysis results for the ewe sacrificed 3 months post surgery.

2-Way ANOVA: Mean ETA			
Parameter	F Value	P Value	Significance
Sector	0.192	0.956	No
Season of Sacrifice	18.873	<0.001	Yes
Sector x Season of Sacrifice	0.102	1.00	No
2 -Way ANOVA: Standard Deviation ETA			
Parameter	F Value	P Value	Significance
Sector	0.958	0.446	No
Season of Sacrifice	6.437	<0.001	Yes
Sector x Season of Sacrifice	0.31	0.310	No

To evaluate the seasonal effects, it is necessary to look further into the results using a *post-hoc* Fisher LSD analysis to determine the differences in ETA. The analysis comparing the seasonal ETAs can be seen in Table 3. The statistical analysis of the mean ETA shows the following results, (spring = fall) $\neq$ (winter = summer), where $\neq$ demonstrates significant statistical difference and = demonstrates no significant difference. The mean ETA of spring and fall are similar and the mean ETA of winter and summer are similar. The analysis comparing the standard deviation ETA present (winter = fall) $\neq$ spring = summer. The standard deviation of winter and fall are similar but both different from spring and similar to summer. These comparisons between mean and standard deviation ETA are the basic differences in season for a healthy sheep.

Table 3 Summary of Fisher LSD comparisons for the 2-Way ANOVA analysis of season within the control group of sheep sacrificed at 3 months.

Fisher LSD: Mean ETA & Season of Sacrifice		
Sacrifice Season within Control		
Comparison	P Value	Difference
Summer vs. Fall	<0.001	Yes
Summer vs. Spring	<0.001	Yes
Summer vs. Winter	0.238	No
Winter vs. Fall	<0.001	Yes
Winter vs. Spring	<0.001	Yes
Spring vs. Fall	0.68	No
Fisher LSD: SD ETA & Season of Sacrifice		
Sacrifice Season within Control		
Comparison	P Value	Difference
Winter vs. Spring	<0.001	Yes
Winter vs. Summer	<0.001	Yes
Winter vs. Fall	0.066	No
Fall vs. Spring	0.03	Yes
Fall vs. Summer	0.117	No
Summer vs. Spring	0.498	No

3.3 3-Way ANOVA

Two groups of 3-way ANOVA analyses were performed using Sigma Plot 11.0 (Systat Software, Inc.): the first to compare the different factors by mean ETA; and the second by standard deviation ETA.

3.3.1 3-Way ANOVA: Season of Sacrifice

Two 3-way ANOVA analyses were performed using Sigma Plot 11.0 (Systat Software, Inc.): the first to analyze the effects of sector, treatment, and season of sacrifice on the dependent variable mean ETA; and the second to analyze the effects of sector, treatment, and season of sacrifice on the dependent variable standard deviation ETA.

The comparison of sector, treatment, and sacrifice season, using the mean ETA as

the dependent data variable provided the following results. The 3 way interaction, sector*treatment*season of sacrifice, did not produce a statistically significant interaction, Table 4. The analysis compared interactions between sector and treatment, sector and season of sacrifice, and treatment and season of sacrifice. The treatment and season of sacrifice interaction showed statistical significance. Based on the significant interactions and p-values, it was concluded there is no significant difference between sectors when comparing mean ETA. The same results were observed when comparing standard deviation ETA. In OVX and control animals the variation in the density of the bone material in the radius is similar between anatomical sectors, for animals sacrificed 3 months post ovariectomy.

Table 4 3-Way ANOVA results, including season of sacrifice. Analysis performed at significance level of .05.

3-Way ANOVA: Mean ETA & Season of Sacrifice			
Parameter	F Value	P Value	Significance
Sector	0.779	0.551	No
Treatment	45.122	<0.001	Yes
Season of Sacrifice	46.557	<0.001	Yes
Sector x Treatment	0.463	0.803	No
Sector x Season of Sacrifice	0.549	0.911	No
Treatment x Season of Sacrifice	12.57	<0.001	Yes
Sector x Treatment x Season of Sacrifice	0.262	0.998	No
3-Way ANOVA: SD ETA & Season of Sacrifice			
Parameter	F Value	P Value	Significance
Sector	0.783	0.563	No
Treatment	0.715	0.398	No
Season of Sacrifice	11.939	<0.001	Yes
Sector x Treatment	0.248	0.941	No
Sector x Season of Sacrifice	0.247	0.998	No
Treatment x Season of Sacrifice	4.648	0.003	Yes
Sector x Treatment x Season of Sacrifice	0.33	0.992	No

To evaluate the seasonal interactions, it is necessary to look further into the results using a post-hoc Fisher LSD analysis to determine the differences in ETA. The analysis to determine the differences in mean ETA was completed for the significant interactions, Table 5. In the group of ewe who underwent an ovariectomy the following interactions were observed for mean ETA, $\text{fall} \neq (\text{spring} = \text{summer} = \text{winter})$. Thus, fall shows a difference in mean ETA from any other season and spring, summer, and winter are not demonstrably different from each other. In the control group, differences were assessed for mean ETA, $\text{spring} \neq \text{summer} \neq (\text{winter} = \text{fall})$. Thus, spring and summer show a significant difference from any other season, and winter and fall are not statistically different.

The same interactions seen with season of sacrifice were observed in the comparisons between sector, treatment, and season of sacrifice using the dependent variable standard deviation ETA, Table 4. The standard deviation ETA analysis produced different Fisher LSD results than those seen using mean ETA, Table 5. Based on the Fisher LSD analysis using standard deviation ETA for the OVX treatment group, $\text{fall} \neq ((\text{winter} \neq \text{spring}) = \text{summer})$. The standard deviation ETA of fall is significantly different than all other seasons and the standard deviation ETA of winter and spring are different but are both similar to summer. Within the control group, differences were assessed for the standard deviation ETA, $\text{fall} = (\text{spring} \neq (\text{winter} = \text{summer}))$. Fall is similar to all other seasons.

Table 5 Summary of *post hoc* Fisher LSD Analysis for data containing season of sacrifice. Data table has been separated by mean ETA and standard deviation ETA.

Fisher LSD: Mean ETA & Season of Sacrifice		
Sacrifice Season within OVX		
Comparison	P Value	Difference
Winter vs. Fall	<0.001	Yes
Winter vs. Summer	0.139	No
Winter vs. Spring	0.713	No
Spring vs. Fall	<0.001	Yes
Spring vs. Summer	0.26	No
Summer vs. Fall	0.005	Yes
Sacrifice Season within Control		
Comparison	P Value	Difference
Spring vs. Fall	<0.001	Yes
Spring vs. Winter	<0.001	Yes
Spring vs. Summer	0.017	Yes
Summer vs. Fall	<0.001	Yes
Summer vs. Winter	<0.001	Yes
Winter vs. Fall	0.314	No
Fisher LSD: Standard Deviation ETA & Season of Sacrifice		
Sacrifice Season within OVX		
Comparison	P Value	Difference
Fall vs. Winter	<0.001	Yes
Fall vs. Summer	<0.001	Yes
Fall vs. Spring	<0.001	Yes
Spring vs. Winter	0.016	Yes
Spring vs. Summer	0.064	No
Summer vs. Winter	0.633	No
Sacrifice Season within Control		
Comparison	P Value	Difference
Spring vs. Summer	0.004	Yes
Spring vs. Winter	0.016	Yes
Spring vs. Fall	0.100	No
Fall vs. Summer	0.211	No
Fall vs. Winter	0.434	No
Winter vs. Summer	0.639	No

3.3.2 3-Way ANOVA: Season of Surgery

Two 3-way ANOVA's were also performed using Sigma Plot 11.0 (Systat Software, Inc.) to analyze the impact of the sector, treatment, and season of surgery with the dependent data variables mean ETA for the first analysis and standard deviation ETA in the second analysis.

The analysis results comparing sector, treatment, and season of surgery based on mean ETA are provided in Table 6. The tested interaction between sector, treatment, and season of surgery showed no significant interaction. The ANOVA further compared interactions between sector and treatment, sector and season of surgery, and treatment and season of surgery. The results of the ANOVA led to the conclusion that there is a significant interaction between treatment and season of surgery. The main effects of sector do not show a significant impact on mean ETA. The significant results of the interactions comparing standard deviation ETA are the same as those comparing mean ETA, Table 6.

Table 6 3-Way ANOVA results based on season of surgery for the animals sacrificed at 3 months. Analysis was performed at significance level of .05.

3-Way ANOVA: Mean ETA & Season of Surgery			
Parameter	F Value	P Value	Significance
Sector	0.779	0.551	No
Treatment	45.122	<0.001	Yes
Season of Surgery	46.557	<0.001	Yes
Sector x Treatment	0.463	0.803	No
Sector x Season of Surgery	0.549	0.911	No
Treatment x Season of Surgery	12.57	<0.001	Yes
Sector x Treatment x Season of Surgery	0.262	0.998	No
3-Way ANOVA: Standard Deviation ETA & Season of Surgery			
Parameter	F Value	P Value	Significance
Sector	0.783	0.563	No
Treatment	0.715	0.398	No
Season of Surgery	11.939	<0.001	Yes
Sector x Treatment	0.248	0.941	No
Sector x Season of Surgery	0.247	0.998	No
Treatment x Season of Surgery	4.648	0.003	Yes
Sector x Treatment x Season of Surgery	0.33	0.992	No

Based on the analysis comparing mean ETA, the interactions between the significant factors, the results of this *post hoc* Fisher LSD analysis are seen in Table 7.

Ewe who underwent an ovariectomy showed differences in mean ETA, summer $\neq$ (fall = spring = winter). The mean ETA sheep ovariectomized during the summer is significantly different than those who had the surgery in fall, spring, or winter, who have similar mean ETA values. The control group showed differences in mean ETA as well, winter $\neq$ spring $\neq$ (fall = summer). The mean ETA in winter and spring were significantly different than the mean ETA in fall and summer, which showed similar results. These differences are different from those seen with season of sacrifice as a variable.

The differences in the *post hoc* Fisher LSD analysis based on standard deviation ETA are seen in Table 7. Significant differences in standard deviation ETA in ewes who underwent an ovariectomy were evident, summer $\neq$ ((fall $\neq$ winter) = spring). The standard deviation ETA within summer is different from all other seasons. In ewes who underwent a sham operation, the Fisher analysis of standard deviation ETA demonstrated that summer = ((fall = spring) $\neq$ winter). Fall and spring show similar standard deviations in ETA, as does summer with all other seasons. Winter appears to show significantly different results from fall and spring. The evident differences within treatment based on season of surgery are different than those seen based on season of sacrifice.

Table 7 Summary of *post hoc* Fisher LSD Analysis for data including season of surgery. Data table has been separated by mean ETA and standard deviation ETA.

Fisher LSD: Mean ETA & Season of Surgery		
Season of Surgery within OVX		
Comparison	P Value	Difference
Fall vs. Summer	<0.001	Yes
Fall vs. Spring	0.139	No
Fall vs. Winter	0.713	No
Winter vs. Summer	<0.001	Yes
Winter vs. Spring	0.26	No
Spring vs. Summer	0.005	Yes
Season of Surgery within Control		
Comparison	P Value	Difference
Winter vs. Summer	<0.001	Yes
Winter vs. Fall	<0.001	Yes
Winter vs. Spring	0.017	Yes
Spring vs. Summer	<0.001	Yes
Spring vs. Fall	<0.001	Yes
Fall vs. Summer	0.314	No
Fisher LSD: Standard Deviation ETA & Season of Surgery		
Season of Surgery within OVX		
Comparison	P Value	Difference
Summer vs. Fall	<0.001	Yes
Summer vs. Spring	<0.001	Yes
Summer vs. Winter	<0.001	Yes
Winter vs. Fall	0.016	Yes
Winter vs. Spring	0.064	No
Spring vs. Fall	0.633	No
Season of Surgery within Control		
Comparison	P Value	Difference
Winter vs. Spring	0.004	Yes
Winter vs. Fall	0.016	Yes
Winter vs. Summer	0.1	No
Summer vs. Spring	0.211	No
Summer vs. Fall	0.434	No
Fall vs. Spring	0.639	No

3.4 Frequency Distributions

Frequency distributions of each group of treatments were analyzed to better understand the distribution of the data. The ETA for all groups at each bone pixel was separated into 20 equal bins and graphed, Figure 13. The ETA was separated into OVX and sham surgery ETA values and graphed showing a count of the ETA values present in each of 20 bins, Figure 14. ETA was segregated by anatomical sector and graphed in 20 bins, Figure 15. The figure includes all 6 anatomical sectors on the same graph. Once the similarities in anatomical sector were seen, each sector was separated by OVX and sham ewe and graphed, Figure 16 - Figure 21.

Figure 13. A frequency curve distribution, which includes all ETA values for sheep sacrificed at 3 months, including OVX and control. The x axis contains bins 1-20, additionally displaying the range of each bin. The mean of each bin can be seen in the table below the graph.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
OVX: Mean ETA (mm AI)	--	--	0.001	0.014	0.026	0.038	0.050	0.062	0.073	0.085	0.096	0.108	0.120	0.132	0.142	--	--	--	--	--
Control: Mean ETA (mm AI)	-0.028	--	0.001	0.014	0.026	0.038	0.049	0.061	0.074	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210

Figure 14. A frequency curve distribution including ETA values separated into OVX and control ewes, for ewes sacrificed at 3 months. The mean of each bin for OVX and control groups can be seen in the table below the graph. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Craniomedial:																				
Mean ETA (mm AI)	--	--	0.001	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210
Cranial: Mean ETA (mm AI)	-0.028	--	0.001	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210
Craniolateral:																				
Mean ETA (mm AI)	--	--	0.001	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210
Caudomedial:																				
Mean ETA (mm AI)	--	--	0.001	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210
Caudal: Mean ETA (mm AI)	--	--	0.001	0.014	0.026	0.038	0.050	0.064	0.073	0.085	0.097	0.108	0.120	0.132	0.143	0.154	0.167	0.180	0.192	0.210
Caudolateral:																				
Mean ETA (mm AI)	--	--	0.001	0.014	0.026	0.038	0.050	0.064	0.073	0.085	0.097	0.108	0.120	0.132	0.143	0.154	0.167	0.180	0.192	0.210

Figure 15. A frequency distribution of the count of ETA in each bin group in each anatomical sector for all ewes sacrificed at 3 months. The mean of each bin can be seen in the table below the graph. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Craniomedial (Control): Mean ETA (mm Al)	-	-	0.001	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210
Craniomedial (OVX): Mean ETA (mm Al)	-	-	0.001	0.014	0.026	0.038	0.050	0.062	0.073	0.085	0.096	0.108	0.120	0.132	0.142	-	-	-	-	-

Figure 16. Count of ETA for craniomedial sector separated by control and sham ewe, for ewe sacrificed at 3 months. The table below the graph shows the mean of each bin. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cranial (Control): Mean ETA (mm Al)	-0.028	-	0.001	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.120	0.132	0.144	0.154	0.167	0.180	0.192	0.210
Cranial (OVX): Mean ETA (mm Al)	-	-	0.001	0.014	0.026	0.038	0.050	0.062	0.073	0.085	0.096	0.108	0.120	0.132	0.142	-	-	-	-	-

Figure 17. Count of ETA for cranial sector separated by control and sham ewe, for ewe sacrificed at 3 months. The table below the graph shows the mean of each bin. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Craniolateral (Control):																				
Mean ETA (mm Al)	-	-	7E-04	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.12	0.132	0.144	0.154	0.167	0.18	0.192	0.21
Craniolateral (OVX):																				
Mean ETA (mm Al)	-	-	7E-04	0.014	0.026	0.038	0.05	0.062	0.073	0.085	0.096	0.108	0.12	0.132	0.142	-	-	-	-	-

Figure 18. Count of ETA for craniolateral sector separated by control and sham ewe, for ewe sacrificed at 3 months. The table below the graph shows the mean of each bin. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Caudomedial (Control):																				
Mean ETA (mm Al)	-	-	7E-04	0.014	0.026	0.038	0.049	0.061	0.073	0.085	0.097	0.108	0.12	0.132	0.144	0.154	0.167	0.18	0.192	0.21
Caudomedial (OVX):																				
Mean ETA (mm Al)	-	-	7E-04	0.014	0.026	0.038	0.05	0.062	0.073	0.085	0.096	0.108	0.12	0.132	0.142	-	-	-	-	-

Figure 19. Count of ETA for caudomedial sector separated by control and sham ewe, for ewe sacrificed at 3 months. The table below the graph shows the mean of each bin. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Caudal (Control): Mean ETA (mm AI)	-	-	6E-04	0.014	0.026	0.038	0.05	0.061	0.073	0.085	0.097	0.108	0.12	0.132	0.144	0.154	0.167	0.18	0.192	0.21
Caudal (OVX): Mean ETA (mm AI)	-	-	7E-04	0.014	0.026	0.038	0.05	0.062	0.073	0.085	0.096	0.108	0.12	0.132	0.142	-	-	-	-	-

Figure 20. Count of ETA for caudal sector separated by control and sham ewe, for ewe sacrificed at 3 months. The table below the graph shows the mean of each bin. The bin distribution is equal to that seen in Figure 13.

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Caudolateral (Control): Mean ETA (mm AI)	-	-	6E-04	0.014	0.026	0.038	0.05	0.061	0.073	0.085	0.097	0.108	0.12	0.132	0.144	0.154	0.167	0.18	0.192	0.21
Caudolateral (OVX): Mean ETA (mm AI)	-	-	7E-04	0.014	0.026	0.038	0.05	0.062	0.073	0.085	0.096	0.108	0.12	0.132	0.142	-	-	-	-	-

Figure 21. Count of ETA for caudolateral sector separated by control and sham ewe, for ewe sacrificed at 3 months. The table below the graph shows the mean of each bin. The bin distribution is equal to that seen in Figure 13.

4. ANALYSIS AND DISCUSSION

Individuals who have been diagnosed with osteoporosis are considered to have a low bone mineral density causing bone fragility and an increased risk of bone fracture [18]. The condition has become a financial detriment to society, costing \$5-\$10 billion in healthcare annually [2]. Many of the dollars are spent treating patients with fractures and related health conditions caused by the decreased bone mass. The disease is often diagnosed using a Dual energy X-ray absorptiometer. If the bone density levels fall within the range of osteoporosis then the patient is diagnosed with the disease [30]. When diagnosed with osteoporosis early, several preventative treatments are possible [23]. Patients can be treated with pharmacological treatments including bisphosphonates, estrogen/progesterone or SERM's [24], [22]. The objective of treatments is to reduce the impact of decreased bone mineral density on daily activities.

In this study, low bone density levels were evaluated in sheep that had a depletion of estrogen due to the removal of their ovaries. The result is induced estrogen depletion, which simulates a change in the bone material. Factors in the study included treatment, season of surgery, season of sacrifice, and anatomical sector. Variation in bone density data was evaluated comparing mean and standard deviation ETA. The mean ETA values represent the average amount of bone material present and the standard deviation ETA represents the variation within the amount of bone material. By understanding the variation within mean ETA for each group, it is possible to ascertain conclusions about how BMD shows variation with different levels of estrogen.

Sheep are an effective animal model to be used in the study of osteoporosis because of the characteristics similar to those in humans. The metabolic rate of a sheep is

similar to that in a human [27]. Also, the regulation of hormones is similar to that in an adult woman [26]. When induced with estrogen depletion, sheep demonstrate a decrease in bone mineral density as well as bone loss. These are important similarities between humans and sheep to understand in the study, in addition to the docile nature of the animal.

In addition to the basic characteristic responses to estrogen depletion it is necessary to understand the reproductive response cycle in sheep. It is known that reproductive responses in sheep can differ based on several factors including season. Reproductive responses to shorter days are mediated by melatonin secreted by the pineal gland during the night. It has been proven that injections of melatonin into sheep with a removed pineal gland can stimulate the effect of shorter days, generally winter, and inhibit the effects of long days, generally the summer. During the day lengths of a typical breeding season, a marked rise in melatonin can be seen. Based on this knowledge, the capacity of estradiol to inhibit the frequency of the luteinizing hormone (LH) changes with season [31]. When LH is present estrus cycles are triggered. In sheep, the reproductive cycle in non-pregnant ewe consists of two distinct rhythms. The first consists of a regular estrus cycle, which extends from 16-17 days. The second is the anestrus cycle, during which no menstrual cycle occurs. The anestrus cycle is only present in ewes raised in a temperate climate. Estrogen has the greatest influence from mid November to late January, a winter estrus cycle [32]. The anestrus cycle generally occurs during spring, summer, and fall, from May to September [33]. Through this study, it was possible to better understand how these cycles affect the density of ovine bone from the various statistical analyses performed.

4.1 Analysis

4.1.1 Two-Way Analysis of Variance (ANOVA)

The Two-Way ANOVA established a baseline in the control group to understand what results to expect under natural conditions. In a normal healthy sheep, the differences in mean and standard deviation ETA should be expected between the seasons of sacrifice, showing a variation in the remodeling process. The significance in the variation in mean and standard deviation ETA between seasons is assumed to be due to the variation in the estrus and anestrus cycles. Variations in the cycles cause deeper changes within the remodeling cycle, which is controlled heavily by estrogen, a chemical signal which initiates the activation, resorption, and formation (ARF) process of bone remodeling [6]. Based on the differences between average mean ETA in each season, the largest mean ETA is seen during winter. During winter, the sheep is likely in the period of estrus during which estrogen has the highest effect, promoting the ARF process which increases BMD through the regulation of the resorption phase [32], [8]. The control group of sheep sacrificed at 3 months was used as a baseline for the analysis comparison.

4.1.2 Three-Way ANOVA Sheep Reproductive Response Analysis

4.1.2.1 Three-Way ANOVA: Season of Sacrifice

The results of the 3-way ANOVA showed specific results demonstrating differences between the OVX and control ewes. The results showed a significant interaction between treatment and season of sacrifice, and an insignificant difference in anatomical sector, both for mean ETA and standard deviation ETA. The post surgery control group continued with a normal reproductive cycle; the OVX group's reproductive

cycle was no longer present. With estrogen depletion, the estrus cycle is minimized and possibly eliminated causing the sheep to remain in the anestrus cycle. Theoretically estrogen depletion should cause the OVX group to remain at similar mean ETA levels throughout the year, however this is not the case in this study.

The results of the Fisher LSD analysis of the OVX group show fall mean ETA values being significantly different from all other seasons, while the mean ETA of spring, summer, and winter are similar. In typical osteoporosis treatment, increased intake of Vitamin D has been shown to maintain or increase bone mineral density [21]. Previous studies have begun to understand the effect of vitamin D on rats induced with osteopenia. It is believed that vitamin D stimulates bone formation through the regulation of bone resorption, being the driver of the formation of bone-resorbing osteoclasts acting in a similar fashion to estrogen [34]. Additionally, vitamin D alone is a driver of bone formation [34]. If vitamin D does in fact mimic the actions of estrogen during the remodeling cycle, longer days during the summer would promote bone formation increasing bone density, the results of which could be seen during the fall months, bone formation generally takes 3 months [6]. Although vitamin D is not as significant as estrogen in the bone remodeling process, with estrogen depleted in the OVX group similar results are seen when looking at the treatments when comparing standard deviation, the group with a surgery performed in the summer is identified as having the greatest influence on variation in ETA.

4.1.2.2 3 way ANOVA: Season of Surgery

The results of the 3-way ANOVA season of surgery are the same as those seen in the 3-way ANOVA based on season of sacrifice, because the sheep have only been

through one remodeling cycle. Based on the Fisher LSD analysis, OVX ewes with surgeries performed in the summer months had a mean ETA significantly different from the mean ETA in any other month. The mean ETA values of all other months were similar. The higher mean ETA values seen in summer demonstrate an increased BMD. The increased BMD is potentially due to the additional vitamin D present in the sheep with a surgery performed during the summer. Vitamin D has the potential to mimic the effects of estrogen during the bone remodeling process [34]. Estrogen has been proven to decrease the activation of the resorption process, thus increasing bone density [8]. Within the control group of ewes, the healthy estrus cycle was present causing significant variation between seasons in mean ETA values. The affects of vitamin D are not as significant as those of estrogen in bone remodeling.

4.1.3 Frequency Distributions

Frequency distributions were developed to better understand the variation of ETA data in the control and OVX groups. Five different groupings of the data were graphed using the same bin groupings. The bins were created by determining the maximum and minimum mean ETA value and then dividing the range into 20 equal bins producing a count of the ETA values in each bin. The mean of the ETA values in each bin was then calculated. The most prominent variations were noticed in the Pixel Density Distribution in OVX and Control Ewes graph, Figure 14 and the graphs of Pixel Distribution in OVX and Control in each anatomical sector, Figure 19-Figure 21. The Pixel Distribution in OVX and Control Ewe separated by Sector, Figure 14 demonstrates the similarities between the ETA in each anatomical sector.

The peaks of the OVX curve appear to be approximately 15% taller than the

control curve, displaying kurtosis. Within both the Pixel Density Distribution in OVX and Control Ewes and Pixel Distribution in OVX and Control in each anatomical sector, similar curves are seen in all of the graphs. The difference in the overall shape of the control curve shows a more even distribution than the OVX curve. Because of estrogen depletion, there is less variation in the bone density between seasons and more of the ewes are situated at a bone density in the middle.

4.2 Limitations and Future Direction

Within the design of the study there were specific limitations, including both those with a biological origin and those with a technical origin. Included in this list is the purchase cohort effect. When purchased at auction the sheep were already skeletally mature. Because they were already skeletally mature the sheep had already gone through several complete reproductive cycles which had the potential to affect the results. The previous reproductive cycles are not accounted for in this study. Also there were potential problems with the setup of the microradiographs. These problems included but were not limited to specific sectors appearing washed out under the microscope, some sectors were dense while others were not, and specific sectors were not visible despite the brightest lighting options. Each of the bone sections were in the range of 95-106 microns thick. If a bone sample was at the upper allowed thickness level, the viewing of this more dense sample was more problematic.

When imaging the microradiographs, a future possibility is to treat the images as grey-scale rather than using the full color capabilities of the camera. This could potentially improve visibility of the specimens, by eliminating the effect of the color temperature of the microscope and how the color changes with the rheostat setting.

Potential future directions of study include further analysis of the sheep sacrificed at 12 months that were imaged as part of this study. Statistical analysis similar to what was completed in this study should be completed using the data from the sheep sacrificed at 12 months. The results of the 12-month statistical analysis could then be compared to the results of this study. Additionally the frequency distributions could be further analyzed using a Kolmogorov-Smirnov analysis to better understand the differences between the individual curves present on each distribution.

5. CONCLUSION

The ovariectomized adult ewe was chosen as the economical animal model of choice used in the study to better understand the effects of estrogen depletion in bone. The sheep are an effective model for the study of osteoporosis because they have a metabolic rate similar to that in a human, a similar bone structure, and their docile nature allows for an easy study set up. There are specific limitations that were necessary to take into account, including the need for an ovariectomy to produce accelerated bone loss and a decrease in BMD to simulate osteoporosis caused by estrogen depletion. Sheep do not have a clear-cut menopause period and require the ovariectomy to mimic what is understood in humans. The goal of the study was to better understand the effects of estrogen depletion through the quantification of compact bone density in the ewe at different stages post ovariectomy.

The study separated the 112 ewes into different treatment groups based on season, treatment, and time of sacrifice. First the ovine were separated into groups based on season of surgery: fall, winter, spring, and summer. They were then further grouped into treatments: OVX and sham surgery (control). Post surgery, the groups were then sacrificed at either 3 or 12 months. Only the group sacrificed at 3 months were analyzed in this portion of the study. After sacrifice, the right and left radius and ulna were sent to Henry Ford Hospital for analysis. There the left radius was removed, cut, and ground to a thickness of 100 μ m for microradiograph imaging. When cut, the left radius was separated into 6 anatomical sectors to be used for analysis. The microradiographs contained all 6 anatomical sectors as well as an aluminum stepwedge that was used as the key. Each ewe sacrificed at 3 months and 12 months were imaged and densitometry

analysis was completed on those sacrificed at 3 months. Statistical analysis was performed to understand the similarities and differences between treatment, anatomical sector variation, season of sacrifice, and season of surgery.

The densitometry analysis required the collection of images of each anatomical sector for all sheep as well as images of the corresponding key. When collecting the images it was important to maintain the same light intensity between anatomical sector and the corresponding stepwedge. Based on the light intensity, it was possible to produce a numerical pixel value from 0 to 255. The distribution of the pixel counts was used to determine the equivalent thickness of aluminum (ETA) of each specimen using the parameters of the stepwedge. The unique ETA values of each specimen were used in further analysis to determine the differences between treatment, sector, season of sacrifice, and season of surgery.

The results of the densitometry analysis showed differences and similarities in compact bone density between treatment, sector, season of sacrifice, and season of surgery. Overall, there were significant differences between the sham surgery group (control) and the OVX group, due to the estrogen depletion caused by the ovariectomy. By removing estrogen control from the ewes, the normal reproductive cycle is eliminated causing the compact bone remodeling process to be altered. Within each sector, there also was a difference between the control and OVX groups. Differences were seen within the period of estrus during which estrogen has the most influence. The significance in treatment shows the difference in bone mineral density between a healthy adult and one affected by osteoporosis. The differences in cortical bone remodeling seen within season of sacrifice and season of surgery show the significance of potential non-

hormonal effects such as vitamin D and other factors. Based on the results seen within the ovariectomized groups, the groups do not remain at similar mean ETA values throughout the year, potentially due to non-hormonal effects. Vitamin D is believed to stimulate bone formation in a similar fashion to estrogen by driving the ARF process. The variance seen could potentially be due to the longer days with increased sunlight exposure seen during the summer months.

The similarities and differences concluded in this study show the variation in bone density between a healthy animal and one affected by estrogen depletion. The conclusions of this study are important to take into account when developing new protocols to study the effects of estrogen depletion and its effect on the remodeling cycle and bone density. The effect of each factor considered in the analysis, including treatment, anatomical sector, season of surgery, and season of sacrifice, had different effects on the ewes. To better develop the results of this study it is necessary to better understand the hormonal effects on bone density and the reproductive cycle. The results of this study show varying levels of bone density within all significant factors, indicating that an ovariectomy, the season of sacrifice, and the season of surgery do have an effect on bone density. Variation in anatomical sector is minimal in the ovine model, based on the results of this study the bone density of each anatomical sector is similar.

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7. APPENDIX A: EXAMPLE OF SPECIMEN IMAGES

Caudomedial	
Northeast	Northwest

Southeast	Southwest

Caudal	
Northeast	Northwest

Aluminum Stepwedge for Ewe 32		
Camera Off	0	1

2	3	4

5	6	7

8. APPENDIX B: RAW DATA FOR 1 EWE

Key for Sector in Raw Data	
1	Craniomedial
2	Cranial
3	Craniolateral
4	Caudomedial
5	Caudal
6	Caudolateral

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.0059	0	Winter	ovx	Autumn	3
32	1	0.0114	0	Winter	ovx	Autumn	3
32	1	0.0158	0	Winter	ovx	Autumn	3
32	1	0.0196	0	Winter	ovx	Autumn	3
32	1	0.0228	0	Winter	ovx	Autumn	3
32	1	0.0257	0	Winter	ovx	Autumn	3
32	1	0.0283	0	Winter	ovx	Autumn	3
32	1	0.0306	0	Winter	ovx	Autumn	3
32	1	0.0327	0	Winter	ovx	Autumn	3
32	1	0.0347	0	Winter	ovx	Autumn	3
32	1	0.0365	0	Winter	ovx	Autumn	3
32	1	0.0382	0	Winter	ovx	Autumn	3
32	1	0.0398	0	Winter	ovx	Autumn	3
32	1	0.0413	0	Winter	ovx	Autumn	3
32	1	0.0427	0	Winter	ovx	Autumn	3
32	1	0.0441	0	Winter	ovx	Autumn	3
32	1	0.0454	0	Winter	ovx	Autumn	3
32	1	0.0466	0	Winter	ovx	Autumn	3
32	1	0.0478	0	Winter	ovx	Autumn	3
32	1	0.0489	0	Winter	ovx	Autumn	3
32	1	0.0500	0	Winter	ovx	Autumn	3
32	1	0.0510	0	Winter	ovx	Autumn	3
32	1	0.0520	36605	Winter	ovx	Autumn	3
32	1	0.0530	43953	Winter	ovx	Autumn	3
32	1	0.0539	45526	Winter	ovx	Autumn	3
32	1	0.0548	50590	Winter	ovx	Autumn	3
32	1	0.0557	49640	Winter	ovx	Autumn	3
32	1	0.0566	52279	Winter	ovx	Autumn	3
32	1	0.0574	52760	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.0582	53690	Winter	ovx	Autumn	3
32	1	0.0590	58309	Winter	ovx	Autumn	3
32	1	0.0597	61116	Winter	ovx	Autumn	3
32	1	0.0605	66335	Winter	ovx	Autumn	3
32	1	0.0612	75162	Winter	ovx	Autumn	3
32	1	0.0619	80769	Winter	ovx	Autumn	3
32	1	0.0626	88839	Winter	ovx	Autumn	3
32	1	0.0633	91475	Winter	ovx	Autumn	3
32	1	0.0640	99996	Winter	ovx	Autumn	3
32	1	0.0646	105409	Winter	ovx	Autumn	3
32	1	0.0652	109374	Winter	ovx	Autumn	3
32	1	0.0659	117971	Winter	ovx	Autumn	3
32	1	0.0665	125427	Winter	ovx	Autumn	3
32	1	0.0671	131714	Winter	ovx	Autumn	3
32	1	0.0677	136761	Winter	ovx	Autumn	3
32	1	0.0683	140128	Winter	ovx	Autumn	3
32	1	0.0688	142909	Winter	ovx	Autumn	3
32	1	0.0694	147827	Winter	ovx	Autumn	3
32	1	0.0699	151210	Winter	ovx	Autumn	3
32	1	0.0705	155333	Winter	ovx	Autumn	3
32	1	0.0710	159183	Winter	ovx	Autumn	3
32	1	0.0716	163141	Winter	ovx	Autumn	3
32	1	0.0721	166740	Winter	ovx	Autumn	3
32	1	0.0726	168995	Winter	ovx	Autumn	3
32	1	0.0731	170999	Winter	ovx	Autumn	3
32	1	0.0736	172816	Winter	ovx	Autumn	3
32	1	0.0741	174558	Winter	ovx	Autumn	3
32	1	0.0746	175523	Winter	ovx	Autumn	3
32	1	0.0751	174292	Winter	ovx	Autumn	3
32	1	0.0755	171566	Winter	ovx	Autumn	3
32	1	0.0760	166433	Winter	ovx	Autumn	3
32	1	0.0765	158849	Winter	ovx	Autumn	3
32	1	0.0769	149370	Winter	ovx	Autumn	3
32	1	0.0774	138358	Winter	ovx	Autumn	3
32	1	0.0778	126473	Winter	ovx	Autumn	3
32	1	0.0783	114066	Winter	ovx	Autumn	3
32	1	0.0787	100428	Winter	ovx	Autumn	3
32	1	0.0791	87559	Winter	ovx	Autumn	3
32	1	0.0796	75068	Winter	ovx	Autumn	3
32	1	0.0800	63045	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.0804	52507	Winter	ovx	Autumn	3
32	1	0.0808	43583	Winter	ovx	Autumn	3
32	1	0.0812	35223	Winter	ovx	Autumn	3
32	1	0.0816	28610	Winter	ovx	Autumn	3
32	1	0.0820	22520	Winter	ovx	Autumn	3
32	1	0.0824	18073	Winter	ovx	Autumn	3
32	1	0.0828	14105	Winter	ovx	Autumn	3
32	1	0.0832	10953	Winter	ovx	Autumn	3
32	1	0.0836	8345	Winter	ovx	Autumn	3
32	1	0.0840	6261	Winter	ovx	Autumn	3
32	1	0.0844	4831	Winter	ovx	Autumn	3
32	1	0.0848	3509	Winter	ovx	Autumn	3
32	1	0.0852	2625	Winter	ovx	Autumn	3
32	1	0.0855	1890	Winter	ovx	Autumn	3
32	1	0.0859	1342	Winter	ovx	Autumn	3
32	1	0.0863	995	Winter	ovx	Autumn	3
32	1	0.0867	687	Winter	ovx	Autumn	3
32	1	0.0870	455	Winter	ovx	Autumn	3
32	1	0.0874	336	Winter	ovx	Autumn	3
32	1	0.0878	272	Winter	ovx	Autumn	3
32	1	0.0881	168	Winter	ovx	Autumn	3
32	1	0.0885	114	Winter	ovx	Autumn	3
32	1	0.0888	84	Winter	ovx	Autumn	3
32	1	0.0892	61	Winter	ovx	Autumn	3
32	1	0.0895	47	Winter	ovx	Autumn	3
32	1	0.0899	42	Winter	ovx	Autumn	3
32	1	0.0902	25	Winter	ovx	Autumn	3
32	1	0.0906	25	Winter	ovx	Autumn	3
32	1	0.0909	15	Winter	ovx	Autumn	3
32	1	0.0913	15	Winter	ovx	Autumn	3
32	1	0.0916	8	Winter	ovx	Autumn	3
32	1	0.0919	3	Winter	ovx	Autumn	3
32	1	0.0923	1	Winter	ovx	Autumn	3
32	1	0.0926	1	Winter	ovx	Autumn	3
32	1	0.0930	1	Winter	ovx	Autumn	3
32	1	0.0933	0	Winter	ovx	Autumn	3
32	1	0.0936	1	Winter	ovx	Autumn	3
32	1	0.0939	0	Winter	ovx	Autumn	3
32	1	0.0943	0	Winter	ovx	Autumn	3
32	1	0.0946	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.0949	0	Winter	ovx	Autumn	3
32	1	0.0953	0	Winter	ovx	Autumn	3
32	1	0.0956	0	Winter	ovx	Autumn	3
32	1	0.0959	0	Winter	ovx	Autumn	3
32	1	0.0962	0	Winter	ovx	Autumn	3
32	1	0.0965	0	Winter	ovx	Autumn	3
32	1	0.0969	0	Winter	ovx	Autumn	3
32	1	0.0972	0	Winter	ovx	Autumn	3
32	1	0.0975	0	Winter	ovx	Autumn	3
32	1	0.0978	0	Winter	ovx	Autumn	3
32	1	0.0981	0	Winter	ovx	Autumn	3
32	1	0.0984	0	Winter	ovx	Autumn	3
32	1	0.0988	0	Winter	ovx	Autumn	3
32	1	0.0991	0	Winter	ovx	Autumn	3
32	1	0.0994	0	Winter	ovx	Autumn	3
32	1	0.0997	0	Winter	ovx	Autumn	3
32	1	0.1000	0	Winter	ovx	Autumn	3
32	1	0.1003	0	Winter	ovx	Autumn	3
32	1	0.1006	0	Winter	ovx	Autumn	3
32	1	0.1009	0	Winter	ovx	Autumn	3
32	1	0.1012	0	Winter	ovx	Autumn	3
32	1	0.1015	0	Winter	ovx	Autumn	3
32	1	0.1018	0	Winter	ovx	Autumn	3
32	1	0.1022	0	Winter	ovx	Autumn	3
32	1	0.1025	0	Winter	ovx	Autumn	3
32	1	0.1028	0	Winter	ovx	Autumn	3
32	1	0.1031	0	Winter	ovx	Autumn	3
32	1	0.1034	0	Winter	ovx	Autumn	3
32	1	0.1037	0	Winter	ovx	Autumn	3
32	1	0.1040	0	Winter	ovx	Autumn	3
32	1	0.1043	0	Winter	ovx	Autumn	3
32	1	0.1046	0	Winter	ovx	Autumn	3
32	1	0.1049	0	Winter	ovx	Autumn	3
32	1	0.1052	0	Winter	ovx	Autumn	3
32	1	0.1055	0	Winter	ovx	Autumn	3
32	1	0.1058	0	Winter	ovx	Autumn	3
32	1	0.1061	0	Winter	ovx	Autumn	3
32	1	0.1064	0	Winter	ovx	Autumn	3
32	1	0.1067	0	Winter	ovx	Autumn	3
32	1	0.1070	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.1073	0	Winter	ovx	Autumn	3
32	1	0.1076	0	Winter	ovx	Autumn	3
32	1	0.1079	0	Winter	ovx	Autumn	3
32	1	0.1082	0	Winter	ovx	Autumn	3
32	1	0.1085	0	Winter	ovx	Autumn	3
32	1	0.1088	0	Winter	ovx	Autumn	3
32	1	0.1091	0	Winter	ovx	Autumn	3
32	1	0.1094	0	Winter	ovx	Autumn	3
32	1	0.1097	0	Winter	ovx	Autumn	3
32	1	0.1100	0	Winter	ovx	Autumn	3
32	1	0.1103	0	Winter	ovx	Autumn	3
32	1	0.1106	0	Winter	ovx	Autumn	3
32	1	0.1109	0	Winter	ovx	Autumn	3
32	1	0.1112	0	Winter	ovx	Autumn	3
32	1	0.1115	0	Winter	ovx	Autumn	3
32	1	0.1118	0	Winter	ovx	Autumn	3
32	1	0.1122	0	Winter	ovx	Autumn	3
32	1	0.1125	0	Winter	ovx	Autumn	3
32	1	0.1128	0	Winter	ovx	Autumn	3
32	1	0.1131	0	Winter	ovx	Autumn	3
32	1	0.1134	0	Winter	ovx	Autumn	3
32	1	0.1137	0	Winter	ovx	Autumn	3
32	1	0.1140	0	Winter	ovx	Autumn	3
32	1	0.1143	0	Winter	ovx	Autumn	3
32	1	0.1146	0	Winter	ovx	Autumn	3
32	1	0.1149	0	Winter	ovx	Autumn	3
32	1	0.1152	0	Winter	ovx	Autumn	3
32	1	0.1155	0	Winter	ovx	Autumn	3
32	1	0.1158	0	Winter	ovx	Autumn	3
32	1	0.1161	0	Winter	ovx	Autumn	3
32	1	0.1165	0	Winter	ovx	Autumn	3
32	1	0.1168	0	Winter	ovx	Autumn	3
32	1	0.1171	0	Winter	ovx	Autumn	3
32	1	0.1174	0	Winter	ovx	Autumn	3
32	1	0.1177	0	Winter	ovx	Autumn	3
32	1	0.1180	0	Winter	ovx	Autumn	3
32	1	0.1183	0	Winter	ovx	Autumn	3
32	1	0.1187	0	Winter	ovx	Autumn	3
32	1	0.1190	0	Winter	ovx	Autumn	3
32	1	0.1193	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.1196	0	Winter	ovx	Autumn	3
32	1	0.1199	0	Winter	ovx	Autumn	3
32	1	0.1203	0	Winter	ovx	Autumn	3
32	1	0.1206	0	Winter	ovx	Autumn	3
32	1	0.1209	0	Winter	ovx	Autumn	3
32	1	0.1212	0	Winter	ovx	Autumn	3
32	1	0.1216	0	Winter	ovx	Autumn	3
32	1	0.1219	0	Winter	ovx	Autumn	3
32	1	0.1222	0	Winter	ovx	Autumn	3
32	1	0.1226	0	Winter	ovx	Autumn	3
32	1	0.1229	0	Winter	ovx	Autumn	3
32	1	0.1232	0	Winter	ovx	Autumn	3
32	1	0.1236	0	Winter	ovx	Autumn	3
32	1	0.1239	0	Winter	ovx	Autumn	3
32	1	0.1243	0	Winter	ovx	Autumn	3
32	1	0.1246	0	Winter	ovx	Autumn	3
32	1	0.1249	0	Winter	ovx	Autumn	3
32	1	0.1253	0	Winter	ovx	Autumn	3
32	1	0.1256	0	Winter	ovx	Autumn	3
32	1	0.1260	0	Winter	ovx	Autumn	3
32	1	0.1263	0	Winter	ovx	Autumn	3
32	1	0.1267	0	Winter	ovx	Autumn	3
32	1	0.1270	0	Winter	ovx	Autumn	3
32	1	0.1274	0	Winter	ovx	Autumn	3
32	1	0.1278	0	Winter	ovx	Autumn	3
32	1	0.1281	0	Winter	ovx	Autumn	3
32	1	0.1285	0	Winter	ovx	Autumn	3
32	1	0.1288	0	Winter	ovx	Autumn	3
32	1	0.1292	0	Winter	ovx	Autumn	3
32	1	0.1296	0	Winter	ovx	Autumn	3
32	1	0.1300	0	Winter	ovx	Autumn	3
32	1	0.1303	0	Winter	ovx	Autumn	3
32	1	0.1307	0	Winter	ovx	Autumn	3
32	1	0.1311	0	Winter	ovx	Autumn	3
32	1	0.1315	0	Winter	ovx	Autumn	3
32	1	0.1319	0	Winter	ovx	Autumn	3
32	1	0.1323	0	Winter	ovx	Autumn	3
32	1	0.1327	0	Winter	ovx	Autumn	3
32	1	0.1331	0	Winter	ovx	Autumn	3
32	1	0.1335	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	1	0.1339	0	Winter	ovx	Autumn	3
32	1	0.1343	0	Winter	ovx	Autumn	3
32	1	0.1347	0	Winter	ovx	Autumn	3
32	1	0.1351	0	Winter	ovx	Autumn	3
32	1	0.1355	0	Winter	ovx	Autumn	3
32	1	0.1359	0	Winter	ovx	Autumn	3
32	1	0.1364	0	Winter	ovx	Autumn	3
32	1	0.1368	0	Winter	ovx	Autumn	3
32	1	0.1372	0	Winter	ovx	Autumn	3
32	1	0.1377	0	Winter	ovx	Autumn	3
32	1	0.1381	0	Winter	ovx	Autumn	3
32	1	0.1386	0	Winter	ovx	Autumn	3
32	1	0.1390	0	Winter	ovx	Autumn	3
32	1	0.1395	0	Winter	ovx	Autumn	3
32	1	0.1400	0	Winter	ovx	Autumn	3
32	1	0.1404	0	Winter	ovx	Autumn	3
32	1	0.1409	0	Winter	ovx	Autumn	3
32	1	0.1414	0	Winter	ovx	Autumn	3
32	1	0.1419	0	Winter	ovx	Autumn	3
32	1	0.1424	0	Winter	ovx	Autumn	3
32	1	0.1429	0	Winter	ovx	Autumn	3
32	1	0.1434	0	Winter	ovx	Autumn	3
32	1	0.1439	0	Winter	ovx	Autumn	3
32	1	0.1444	0	Winter	ovx	Autumn	3
32	1	0.1450	0	Winter	ovx	Autumn	3
32	1	0.1455	0	Winter	ovx	Autumn	3
32	1	0.1461	0	Winter	ovx	Autumn	3
32	2	0.0059	0	Winter	ovx	Autumn	3
32	2	0.0114	0	Winter	ovx	Autumn	3
32	2	0.0158	0	Winter	ovx	Autumn	3
32	2	0.0196	0	Winter	ovx	Autumn	3
32	2	0.0228	0	Winter	ovx	Autumn	3
32	2	0.0257	0	Winter	ovx	Autumn	3
32	2	0.0283	0	Winter	ovx	Autumn	3
32	2	0.0306	0	Winter	ovx	Autumn	3
32	2	0.0327	0	Winter	ovx	Autumn	3
32	2	0.0347	0	Winter	ovx	Autumn	3
32	2	0.0365	0	Winter	ovx	Autumn	3
32	2	0.0382	0	Winter	ovx	Autumn	3
32	2	0.0398	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.0413	0	Winter	ovx	Autumn	3
32	2	0.0427	0	Winter	ovx	Autumn	3
32	2	0.0441	0	Winter	ovx	Autumn	3
32	2	0.0454	0	Winter	ovx	Autumn	3
32	2	0.0466	0	Winter	ovx	Autumn	3
32	2	0.0478	0	Winter	ovx	Autumn	3
32	2	0.0489	0	Winter	ovx	Autumn	3
32	2	0.0500	0	Winter	ovx	Autumn	3
32	2	0.0510	43776	Winter	ovx	Autumn	3
32	2	0.0520	47878	Winter	ovx	Autumn	3
32	2	0.0530	53877	Winter	ovx	Autumn	3
32	2	0.0539	54445	Winter	ovx	Autumn	3
32	2	0.0548	59516	Winter	ovx	Autumn	3
32	2	0.0557	62366	Winter	ovx	Autumn	3
32	2	0.0566	69420	Winter	ovx	Autumn	3
32	2	0.0574	72570	Winter	ovx	Autumn	3
32	2	0.0582	75266	Winter	ovx	Autumn	3
32	2	0.0590	86090	Winter	ovx	Autumn	3
32	2	0.0597	90366	Winter	ovx	Autumn	3
32	2	0.0605	98363	Winter	ovx	Autumn	3
32	2	0.0612	112444	Winter	ovx	Autumn	3
32	2	0.0619	120660	Winter	ovx	Autumn	3
32	2	0.0626	134333	Winter	ovx	Autumn	3
32	2	0.0633	138827	Winter	ovx	Autumn	3
32	2	0.0640	151884	Winter	ovx	Autumn	3
32	2	0.0646	156699	Winter	ovx	Autumn	3
32	2	0.0652	159532	Winter	ovx	Autumn	3
32	2	0.0659	165972	Winter	ovx	Autumn	3
32	2	0.0665	168947	Winter	ovx	Autumn	3
32	2	0.0671	171208	Winter	ovx	Autumn	3
32	2	0.0677	174940	Winter	ovx	Autumn	3
32	2	0.0683	175783	Winter	ovx	Autumn	3
32	2	0.0688	177807	Winter	ovx	Autumn	3
32	2	0.0694	179887	Winter	ovx	Autumn	3
32	2	0.0699	180337	Winter	ovx	Autumn	3
32	2	0.0705	181045	Winter	ovx	Autumn	3
32	2	0.0710	180236	Winter	ovx	Autumn	3
32	2	0.0716	178333	Winter	ovx	Autumn	3
32	2	0.0721	172225	Winter	ovx	Autumn	3
32	2	0.0726	166587	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.0731	158556	Winter	ovx	Autumn	3
32	2	0.0736	149976	Winter	ovx	Autumn	3
32	2	0.0741	139515	Winter	ovx	Autumn	3
32	2	0.0746	129632	Winter	ovx	Autumn	3
32	2	0.0751	119984	Winter	ovx	Autumn	3
32	2	0.0755	109347	Winter	ovx	Autumn	3
32	2	0.0760	97866	Winter	ovx	Autumn	3
32	2	0.0765	87293	Winter	ovx	Autumn	3
32	2	0.0769	76240	Winter	ovx	Autumn	3
32	2	0.0774	65933	Winter	ovx	Autumn	3
32	2	0.0778	57082	Winter	ovx	Autumn	3
32	2	0.0783	48460	Winter	ovx	Autumn	3
32	2	0.0787	40008	Winter	ovx	Autumn	3
32	2	0.0791	33270	Winter	ovx	Autumn	3
32	2	0.0796	27530	Winter	ovx	Autumn	3
32	2	0.0800	21813	Winter	ovx	Autumn	3
32	2	0.0804	17441	Winter	ovx	Autumn	3
32	2	0.0808	13856	Winter	ovx	Autumn	3
32	2	0.0812	10792	Winter	ovx	Autumn	3
32	2	0.0816	8444	Winter	ovx	Autumn	3
32	2	0.0820	6518	Winter	ovx	Autumn	3
32	2	0.0824	5133	Winter	ovx	Autumn	3
32	2	0.0828	4094	Winter	ovx	Autumn	3
32	2	0.0832	3231	Winter	ovx	Autumn	3
32	2	0.0836	2495	Winter	ovx	Autumn	3
32	2	0.0840	2028	Winter	ovx	Autumn	3
32	2	0.0844	1659	Winter	ovx	Autumn	3
32	2	0.0848	1267	Winter	ovx	Autumn	3
32	2	0.0852	1081	Winter	ovx	Autumn	3
32	2	0.0855	865	Winter	ovx	Autumn	3
32	2	0.0859	803	Winter	ovx	Autumn	3
32	2	0.0863	655	Winter	ovx	Autumn	3
32	2	0.0867	643	Winter	ovx	Autumn	3
32	2	0.0870	525	Winter	ovx	Autumn	3
32	2	0.0874	454	Winter	ovx	Autumn	3
32	2	0.0878	418	Winter	ovx	Autumn	3
32	2	0.0881	417	Winter	ovx	Autumn	3
32	2	0.0885	357	Winter	ovx	Autumn	3
32	2	0.0888	358	Winter	ovx	Autumn	3
32	2	0.0892	349	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.0895	310	Winter	ovx	Autumn	3
32	2	0.0899	281	Winter	ovx	Autumn	3
32	2	0.0902	267	Winter	ovx	Autumn	3
32	2	0.0906	226	Winter	ovx	Autumn	3
32	2	0.0909	230	Winter	ovx	Autumn	3
32	2	0.0913	234	Winter	ovx	Autumn	3
32	2	0.0916	211	Winter	ovx	Autumn	3
32	2	0.0919	187	Winter	ovx	Autumn	3
32	2	0.0923	153	Winter	ovx	Autumn	3
32	2	0.0926	150	Winter	ovx	Autumn	3
32	2	0.0930	183	Winter	ovx	Autumn	3
32	2	0.0933	131	Winter	ovx	Autumn	3
32	2	0.0936	141	Winter	ovx	Autumn	3
32	2	0.0939	122	Winter	ovx	Autumn	3
32	2	0.0943	102	Winter	ovx	Autumn	3
32	2	0.0946	98	Winter	ovx	Autumn	3
32	2	0.0949	93	Winter	ovx	Autumn	3
32	2	0.0953	89	Winter	ovx	Autumn	3
32	2	0.0956	77	Winter	ovx	Autumn	3
32	2	0.0959	92	Winter	ovx	Autumn	3
32	2	0.0962	69	Winter	ovx	Autumn	3
32	2	0.0965	63	Winter	ovx	Autumn	3
32	2	0.0969	83	Winter	ovx	Autumn	3
32	2	0.0972	55	Winter	ovx	Autumn	3
32	2	0.0975	56	Winter	ovx	Autumn	3
32	2	0.0978	37	Winter	ovx	Autumn	3
32	2	0.0981	49	Winter	ovx	Autumn	3
32	2	0.0984	55	Winter	ovx	Autumn	3
32	2	0.0988	39	Winter	ovx	Autumn	3
32	2	0.0991	34	Winter	ovx	Autumn	3
32	2	0.0994	34	Winter	ovx	Autumn	3
32	2	0.0997	27	Winter	ovx	Autumn	3
32	2	0.1000	24	Winter	ovx	Autumn	3
32	2	0.1003	32	Winter	ovx	Autumn	3
32	2	0.1006	24	Winter	ovx	Autumn	3
32	2	0.1009	14	Winter	ovx	Autumn	3
32	2	0.1012	15	Winter	ovx	Autumn	3
32	2	0.1015	19	Winter	ovx	Autumn	3
32	2	0.1018	20	Winter	ovx	Autumn	3
32	2	0.1022	16	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.1025	13	Winter	ovx	Autumn	3
32	2	0.1028	10	Winter	ovx	Autumn	3
32	2	0.1031	7	Winter	ovx	Autumn	3
32	2	0.1034	11	Winter	ovx	Autumn	3
32	2	0.1037	11	Winter	ovx	Autumn	3
32	2	0.1040	5	Winter	ovx	Autumn	3
32	2	0.1043	6	Winter	ovx	Autumn	3
32	2	0.1046	2	Winter	ovx	Autumn	3
32	2	0.1049	1	Winter	ovx	Autumn	3
32	2	0.1052	1	Winter	ovx	Autumn	3
32	2	0.1055	0	Winter	ovx	Autumn	3
32	2	0.1058	0	Winter	ovx	Autumn	3
32	2	0.1061	0	Winter	ovx	Autumn	3
32	2	0.1064	0	Winter	ovx	Autumn	3
32	2	0.1067	0	Winter	ovx	Autumn	3
32	2	0.1070	0	Winter	ovx	Autumn	3
32	2	0.1073	0	Winter	ovx	Autumn	3
32	2	0.1076	0	Winter	ovx	Autumn	3
32	2	0.1079	0	Winter	ovx	Autumn	3
32	2	0.1082	0	Winter	ovx	Autumn	3
32	2	0.1085	0	Winter	ovx	Autumn	3
32	2	0.1088	0	Winter	ovx	Autumn	3
32	2	0.1091	0	Winter	ovx	Autumn	3
32	2	0.1094	0	Winter	ovx	Autumn	3
32	2	0.1097	0	Winter	ovx	Autumn	3
32	2	0.1100	0	Winter	ovx	Autumn	3
32	2	0.1103	0	Winter	ovx	Autumn	3
32	2	0.1106	0	Winter	ovx	Autumn	3
32	2	0.1109	0	Winter	ovx	Autumn	3
32	2	0.1112	0	Winter	ovx	Autumn	3
32	2	0.1115	0	Winter	ovx	Autumn	3
32	2	0.1118	0	Winter	ovx	Autumn	3
32	2	0.1122	0	Winter	ovx	Autumn	3
32	2	0.1125	0	Winter	ovx	Autumn	3
32	2	0.1128	0	Winter	ovx	Autumn	3
32	2	0.1131	0	Winter	ovx	Autumn	3
32	2	0.1134	0	Winter	ovx	Autumn	3
32	2	0.1137	0	Winter	ovx	Autumn	3
32	2	0.1140	0	Winter	ovx	Autumn	3
32	2	0.1143	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.1146	0	Winter	ovx	Autumn	3
32	2	0.1149	0	Winter	ovx	Autumn	3
32	2	0.1152	0	Winter	ovx	Autumn	3
32	2	0.1155	0	Winter	ovx	Autumn	3
32	2	0.1158	0	Winter	ovx	Autumn	3
32	2	0.1161	0	Winter	ovx	Autumn	3
32	2	0.1165	0	Winter	ovx	Autumn	3
32	2	0.1168	0	Winter	ovx	Autumn	3
32	2	0.1171	0	Winter	ovx	Autumn	3
32	2	0.1174	0	Winter	ovx	Autumn	3
32	2	0.1177	0	Winter	ovx	Autumn	3
32	2	0.1180	0	Winter	ovx	Autumn	3
32	2	0.1183	0	Winter	ovx	Autumn	3
32	2	0.1187	0	Winter	ovx	Autumn	3
32	2	0.1190	0	Winter	ovx	Autumn	3
32	2	0.1193	0	Winter	ovx	Autumn	3
32	2	0.1196	0	Winter	ovx	Autumn	3
32	2	0.1199	0	Winter	ovx	Autumn	3
32	2	0.1203	0	Winter	ovx	Autumn	3
32	2	0.1206	0	Winter	ovx	Autumn	3
32	2	0.1209	0	Winter	ovx	Autumn	3
32	2	0.1212	0	Winter	ovx	Autumn	3
32	2	0.1216	0	Winter	ovx	Autumn	3
32	2	0.1219	0	Winter	ovx	Autumn	3
32	2	0.1222	0	Winter	ovx	Autumn	3
32	2	0.1226	0	Winter	ovx	Autumn	3
32	2	0.1229	0	Winter	ovx	Autumn	3
32	2	0.1232	0	Winter	ovx	Autumn	3
32	2	0.1236	0	Winter	ovx	Autumn	3
32	2	0.1239	0	Winter	ovx	Autumn	3
32	2	0.1243	0	Winter	ovx	Autumn	3
32	2	0.1246	0	Winter	ovx	Autumn	3
32	2	0.1249	0	Winter	ovx	Autumn	3
32	2	0.1253	0	Winter	ovx	Autumn	3
32	2	0.1256	0	Winter	ovx	Autumn	3
32	2	0.1260	0	Winter	ovx	Autumn	3
32	2	0.1263	0	Winter	ovx	Autumn	3
32	2	0.1267	0	Winter	ovx	Autumn	3
32	2	0.1270	0	Winter	ovx	Autumn	3
32	2	0.1274	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.1278	0	Winter	ovx	Autumn	3
32	2	0.1281	0	Winter	ovx	Autumn	3
32	2	0.1285	0	Winter	ovx	Autumn	3
32	2	0.1288	0	Winter	ovx	Autumn	3
32	2	0.1292	0	Winter	ovx	Autumn	3
32	2	0.1296	0	Winter	ovx	Autumn	3
32	2	0.1300	0	Winter	ovx	Autumn	3
32	2	0.1303	0	Winter	ovx	Autumn	3
32	2	0.1307	0	Winter	ovx	Autumn	3
32	2	0.1311	0	Winter	ovx	Autumn	3
32	2	0.1315	0	Winter	ovx	Autumn	3
32	2	0.1319	0	Winter	ovx	Autumn	3
32	2	0.1323	0	Winter	ovx	Autumn	3
32	2	0.1327	0	Winter	ovx	Autumn	3
32	2	0.1331	0	Winter	ovx	Autumn	3
32	2	0.1335	0	Winter	ovx	Autumn	3
32	2	0.1339	0	Winter	ovx	Autumn	3
32	2	0.1343	0	Winter	ovx	Autumn	3
32	2	0.1347	0	Winter	ovx	Autumn	3
32	2	0.1351	0	Winter	ovx	Autumn	3
32	2	0.1355	0	Winter	ovx	Autumn	3
32	2	0.1359	0	Winter	ovx	Autumn	3
32	2	0.1364	0	Winter	ovx	Autumn	3
32	2	0.1368	0	Winter	ovx	Autumn	3
32	2	0.1372	0	Winter	ovx	Autumn	3
32	2	0.1377	0	Winter	ovx	Autumn	3
32	2	0.1381	0	Winter	ovx	Autumn	3
32	2	0.1386	0	Winter	ovx	Autumn	3
32	2	0.1390	0	Winter	ovx	Autumn	3
32	2	0.1395	0	Winter	ovx	Autumn	3
32	2	0.1400	0	Winter	ovx	Autumn	3
32	2	0.1404	0	Winter	ovx	Autumn	3
32	2	0.1409	0	Winter	ovx	Autumn	3
32	2	0.1414	0	Winter	ovx	Autumn	3
32	2	0.1419	0	Winter	ovx	Autumn	3
32	2	0.1424	0	Winter	ovx	Autumn	3
32	2	0.1429	0	Winter	ovx	Autumn	3
32	2	0.1434	0	Winter	ovx	Autumn	3
32	2	0.1439	0	Winter	ovx	Autumn	3
32	2	0.1444	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	2	0.1450	0	Winter	ovx	Autumn	3
32	2	0.1455	0	Winter	ovx	Autumn	3
32	2	0.1461	0	Winter	ovx	Autumn	3
32	3	0.0059	0	Winter	ovx	Autumn	3
32	3	0.0114	452760	Winter	ovx	Autumn	3
32	3	0.0158	14674	Winter	ovx	Autumn	3
32	3	0.0196	12209	Winter	ovx	Autumn	3
32	3	0.0228	12630	Winter	ovx	Autumn	3
32	3	0.0257	12927	Winter	ovx	Autumn	3
32	3	0.0283	11087	Winter	ovx	Autumn	3
32	3	0.0306	13033	Winter	ovx	Autumn	3
32	3	0.0327	11096	Winter	ovx	Autumn	3
32	3	0.0347	13614	Winter	ovx	Autumn	3
32	3	0.0365	13938	Winter	ovx	Autumn	3
32	3	0.0382	15044	Winter	ovx	Autumn	3
32	3	0.0398	21780	Winter	ovx	Autumn	3
32	3	0.0413	19260	Winter	ovx	Autumn	3
32	3	0.0427	27899	Winter	ovx	Autumn	3
32	3	0.0441	30041	Winter	ovx	Autumn	3
32	3	0.0454	32228	Winter	ovx	Autumn	3
32	3	0.0466	44485	Winter	ovx	Autumn	3
32	3	0.0478	51411	Winter	ovx	Autumn	3
32	3	0.0489	63319	Winter	ovx	Autumn	3
32	3	0.0500	81397	Winter	ovx	Autumn	3
32	3	0.0510	78841	Winter	ovx	Autumn	3
32	3	0.0520	90573	Winter	ovx	Autumn	3
32	3	0.0530	90169	Winter	ovx	Autumn	3
32	3	0.0539	101201	Winter	ovx	Autumn	3
32	3	0.0548	109898	Winter	ovx	Autumn	3
32	3	0.0557	115411	Winter	ovx	Autumn	3
32	3	0.0566	128194	Winter	ovx	Autumn	3
32	3	0.0574	127861	Winter	ovx	Autumn	3
32	3	0.0582	132219	Winter	ovx	Autumn	3
32	3	0.0590	132984	Winter	ovx	Autumn	3
32	3	0.0597	129261	Winter	ovx	Autumn	3
32	3	0.0605	133525	Winter	ovx	Autumn	3
32	3	0.0612	130482	Winter	ovx	Autumn	3
32	3	0.0619	136048	Winter	ovx	Autumn	3
32	3	0.0626	140601	Winter	ovx	Autumn	3
32	3	0.0633	139787	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	3	0.0640	150794	Winter	ovx	Autumn	3
32	3	0.0646	151530	Winter	ovx	Autumn	3
32	3	0.0652	154010	Winter	ovx	Autumn	3
32	3	0.0659	158098	Winter	ovx	Autumn	3
32	3	0.0665	159328	Winter	ovx	Autumn	3
32	3	0.0671	160796	Winter	ovx	Autumn	3
32	3	0.0677	157681	Winter	ovx	Autumn	3
32	3	0.0683	154898	Winter	ovx	Autumn	3
32	3	0.0688	150394	Winter	ovx	Autumn	3
32	3	0.0694	145550	Winter	ovx	Autumn	3
32	3	0.0699	140550	Winter	ovx	Autumn	3
32	3	0.0705	133360	Winter	ovx	Autumn	3
32	3	0.0710	125758	Winter	ovx	Autumn	3
32	3	0.0716	117660	Winter	ovx	Autumn	3
32	3	0.0721	108018	Winter	ovx	Autumn	3
32	3	0.0726	100050	Winter	ovx	Autumn	3
32	3	0.0731	89816	Winter	ovx	Autumn	3
32	3	0.0736	81138	Winter	ovx	Autumn	3
32	3	0.0741	71786	Winter	ovx	Autumn	3
32	3	0.0746	63671	Winter	ovx	Autumn	3
32	3	0.0751	55064	Winter	ovx	Autumn	3
32	3	0.0755	47969	Winter	ovx	Autumn	3
32	3	0.0760	40838	Winter	ovx	Autumn	3
32	3	0.0765	34645	Winter	ovx	Autumn	3
32	3	0.0769	28843	Winter	ovx	Autumn	3
32	3	0.0774	24231	Winter	ovx	Autumn	3
32	3	0.0778	19916	Winter	ovx	Autumn	3
32	3	0.0783	16719	Winter	ovx	Autumn	3
32	3	0.0787	13462	Winter	ovx	Autumn	3
32	3	0.0791	11104	Winter	ovx	Autumn	3
32	3	0.0796	8971	Winter	ovx	Autumn	3
32	3	0.0800	7309	Winter	ovx	Autumn	3
32	3	0.0804	6024	Winter	ovx	Autumn	3
32	3	0.0808	4903	Winter	ovx	Autumn	3
32	3	0.0812	4030	Winter	ovx	Autumn	3
32	3	0.0816	3260	Winter	ovx	Autumn	3
32	3	0.0820	2715	Winter	ovx	Autumn	3
32	3	0.0824	2184	Winter	ovx	Autumn	3
32	3	0.0828	1871	Winter	ovx	Autumn	3
32	3	0.0832	1531	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	3	0.0836	1331	Winter	ovx	Autumn	3
32	3	0.0840	1051	Winter	ovx	Autumn	3
32	3	0.0844	845	Winter	ovx	Autumn	3
32	3	0.0848	667	Winter	ovx	Autumn	3
32	3	0.0852	582	Winter	ovx	Autumn	3
32	3	0.0855	482	Winter	ovx	Autumn	3
32	3	0.0859	386	Winter	ovx	Autumn	3
32	3	0.0863	338	Winter	ovx	Autumn	3
32	3	0.0867	233	Winter	ovx	Autumn	3
32	3	0.0870	209	Winter	ovx	Autumn	3
32	3	0.0874	163	Winter	ovx	Autumn	3
32	3	0.0878	143	Winter	ovx	Autumn	3
32	3	0.0881	94	Winter	ovx	Autumn	3
32	3	0.0885	88	Winter	ovx	Autumn	3
32	3	0.0888	53	Winter	ovx	Autumn	3
32	3	0.0892	49	Winter	ovx	Autumn	3
32	3	0.0895	40	Winter	ovx	Autumn	3
32	3	0.0899	45	Winter	ovx	Autumn	3
32	3	0.0902	35	Winter	ovx	Autumn	3
32	3	0.0906	25	Winter	ovx	Autumn	3
32	3	0.0909	16	Winter	ovx	Autumn	3
32	3	0.0913	9	Winter	ovx	Autumn	3
32	3	0.0916	11	Winter	ovx	Autumn	3
32	3	0.0919	10	Winter	ovx	Autumn	3
32	3	0.0923	6	Winter	ovx	Autumn	3
32	3	0.0926	6	Winter	ovx	Autumn	3
32	3	0.0930	6	Winter	ovx	Autumn	3
32	3	0.0933	5	Winter	ovx	Autumn	3
32	3	0.0936	7	Winter	ovx	Autumn	3
32	3	0.0939	2	Winter	ovx	Autumn	3
32	3	0.0943	3	Winter	ovx	Autumn	3
32	3	0.0946	2	Winter	ovx	Autumn	3
32	3	0.0949	6	Winter	ovx	Autumn	3
32	3	0.0953	4	Winter	ovx	Autumn	3
32	3	0.0956	2	Winter	ovx	Autumn	3
32	3	0.0959	1	Winter	ovx	Autumn	3
32	3	0.0962	0	Winter	ovx	Autumn	3
32	3	0.0965	3	Winter	ovx	Autumn	3
32	3	0.0969	0	Winter	ovx	Autumn	3
32	3	0.0972	4	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	3	0.0975	2	Winter	ovx	Autumn	3
32	3	0.0978	4	Winter	ovx	Autumn	3
32	3	0.0981	0	Winter	ovx	Autumn	3
32	3	0.0984	0	Winter	ovx	Autumn	3
32	3	0.0988	2	Winter	ovx	Autumn	3
32	3	0.0991	2	Winter	ovx	Autumn	3
32	3	0.0994	2	Winter	ovx	Autumn	3
32	3	0.0997	0	Winter	ovx	Autumn	3
32	3	0.1000	5	Winter	ovx	Autumn	3
32	3	0.1003	0	Winter	ovx	Autumn	3
32	3	0.1006	1	Winter	ovx	Autumn	3
32	3	0.1009	1	Winter	ovx	Autumn	3
32	3	0.1012	1	Winter	ovx	Autumn	3
32	3	0.1015	0	Winter	ovx	Autumn	3
32	3	0.1018	1	Winter	ovx	Autumn	3
32	3	0.1022	1	Winter	ovx	Autumn	3
32	3	0.1025	1	Winter	ovx	Autumn	3
32	3	0.1028	2	Winter	ovx	Autumn	3
32	3	0.1031	1	Winter	ovx	Autumn	3
32	3	0.1034	0	Winter	ovx	Autumn	3
32	3	0.1037	0	Winter	ovx	Autumn	3
32	3	0.1040	2	Winter	ovx	Autumn	3
32	3	0.1043	1	Winter	ovx	Autumn	3
32	3	0.1046	1	Winter	ovx	Autumn	3
32	3	0.1049	0	Winter	ovx	Autumn	3
32	3	0.1052	0	Winter	ovx	Autumn	3
32	3	0.1055	1	Winter	ovx	Autumn	3
32	3	0.1058	0	Winter	ovx	Autumn	3
32	3	0.1061	1	Winter	ovx	Autumn	3
32	3	0.1064	0	Winter	ovx	Autumn	3
32	3	0.1067	0	Winter	ovx	Autumn	3
32	3	0.1070	0	Winter	ovx	Autumn	3
32	3	0.1073	0	Winter	ovx	Autumn	3
32	3	0.1076	1	Winter	ovx	Autumn	3
32	3	0.1079	0	Winter	ovx	Autumn	3
32	3	0.1082	2	Winter	ovx	Autumn	3
32	3	0.1085	0	Winter	ovx	Autumn	3
32	3	0.1088	0	Winter	ovx	Autumn	3
32	3	0.1091	2	Winter	ovx	Autumn	3
32	3	0.1094	1	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	3	0.1097	1	Winter	ovx	Autumn	3
32	3	0.1100	0	Winter	ovx	Autumn	3
32	3	0.1103	2	Winter	ovx	Autumn	3
32	3	0.1106	2	Winter	ovx	Autumn	3
32	3	0.1109	0	Winter	ovx	Autumn	3
32	3	0.1112	3	Winter	ovx	Autumn	3
32	3	0.1115	0	Winter	ovx	Autumn	3
32	3	0.1118	1	Winter	ovx	Autumn	3
32	3	0.1122	1	Winter	ovx	Autumn	3
32	3	0.1125	0	Winter	ovx	Autumn	3
32	3	0.1128	0	Winter	ovx	Autumn	3
32	3	0.1131	0	Winter	ovx	Autumn	3
32	3	0.1134	0	Winter	ovx	Autumn	3
32	3	0.1137	2	Winter	ovx	Autumn	3
32	3	0.1140	0	Winter	ovx	Autumn	3
32	3	0.1143	2	Winter	ovx	Autumn	3
32	3	0.1146	1	Winter	ovx	Autumn	3
32	3	0.1149	0	Winter	ovx	Autumn	3
32	3	0.1152	0	Winter	ovx	Autumn	3
32	3	0.1155	1	Winter	ovx	Autumn	3
32	3	0.1158	0	Winter	ovx	Autumn	3
32	3	0.1161	1	Winter	ovx	Autumn	3
32	3	0.1165	1	Winter	ovx	Autumn	3
32	3	0.1168	1	Winter	ovx	Autumn	3
32	3	0.1171	0	Winter	ovx	Autumn	3
32	3	0.1174	0	Winter	ovx	Autumn	3
32	3	0.1177	0	Winter	ovx	Autumn	3
32	3	0.1180	0	Winter	ovx	Autumn	3
32	3	0.1183	0	Winter	ovx	Autumn	3
32	3	0.1187	0	Winter	ovx	Autumn	3
32	3	0.1190	0	Winter	ovx	Autumn	3
32	3	0.1193	0	Winter	ovx	Autumn	3
32	3	0.1196	0	Winter	ovx	Autumn	3
32	3	0.1199	0	Winter	ovx	Autumn	3
32	3	0.1203	0	Winter	ovx	Autumn	3
32	3	0.1206	0	Winter	ovx	Autumn	3
32	3	0.1209	0	Winter	ovx	Autumn	3
32	3	0.1212	0	Winter	ovx	Autumn	3
32	3	0.1216	0	Winter	ovx	Autumn	3
32	3	0.1219	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	3	0.1222	0	Winter	ovx	Autumn	3
32	3	0.1226	0	Winter	ovx	Autumn	3
32	3	0.1229	0	Winter	ovx	Autumn	3
32	3	0.1232	0	Winter	ovx	Autumn	3
32	3	0.1236	0	Winter	ovx	Autumn	3
32	3	0.1239	0	Winter	ovx	Autumn	3
32	3	0.1243	0	Winter	ovx	Autumn	3
32	3	0.1246	0	Winter	ovx	Autumn	3
32	3	0.1249	0	Winter	ovx	Autumn	3
32	3	0.1253	0	Winter	ovx	Autumn	3
32	3	0.1256	0	Winter	ovx	Autumn	3
32	3	0.1260	0	Winter	ovx	Autumn	3
32	3	0.1263	0	Winter	ovx	Autumn	3
32	3	0.1267	0	Winter	ovx	Autumn	3
32	3	0.1270	0	Winter	ovx	Autumn	3
32	3	0.1274	0	Winter	ovx	Autumn	3
32	3	0.1278	0	Winter	ovx	Autumn	3
32	3	0.1281	0	Winter	ovx	Autumn	3
32	3	0.1285	0	Winter	ovx	Autumn	3
32	3	0.1288	0	Winter	ovx	Autumn	3
32	3	0.1292	0	Winter	ovx	Autumn	3
32	3	0.1296	0	Winter	ovx	Autumn	3
32	3	0.1300	0	Winter	ovx	Autumn	3
32	3	0.1303	0	Winter	ovx	Autumn	3
32	3	0.1307	0	Winter	ovx	Autumn	3
32	3	0.1311	0	Winter	ovx	Autumn	3
32	3	0.1315	0	Winter	ovx	Autumn	3
32	3	0.1319	0	Winter	ovx	Autumn	3
32	3	0.1323	0	Winter	ovx	Autumn	3
32	3	0.1327	0	Winter	ovx	Autumn	3
32	3	0.1331	0	Winter	ovx	Autumn	3
32	3	0.1335	0	Winter	ovx	Autumn	3
32	3	0.1339	0	Winter	ovx	Autumn	3
32	3	0.1343	0	Winter	ovx	Autumn	3
32	3	0.1347	0	Winter	ovx	Autumn	3
32	3	0.1351	0	Winter	ovx	Autumn	3
32	3	0.1355	0	Winter	ovx	Autumn	3
32	3	0.1359	0	Winter	ovx	Autumn	3
32	3	0.1364	0	Winter	ovx	Autumn	3
32	3	0.1368	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	3	0.1372	0	Winter	ovx	Autumn	3
32	3	0.1377	0	Winter	ovx	Autumn	3
32	3	0.1381	0	Winter	ovx	Autumn	3
32	3	0.1386	0	Winter	ovx	Autumn	3
32	3	0.1390	0	Winter	ovx	Autumn	3
32	3	0.1395	0	Winter	ovx	Autumn	3
32	3	0.1400	0	Winter	ovx	Autumn	3
32	3	0.1404	0	Winter	ovx	Autumn	3
32	3	0.1409	0	Winter	ovx	Autumn	3
32	3	0.1414	0	Winter	ovx	Autumn	3
32	3	0.1419	0	Winter	ovx	Autumn	3
32	3	0.1424	0	Winter	ovx	Autumn	3
32	3	0.1429	0	Winter	ovx	Autumn	3
32	3	0.1434	0	Winter	ovx	Autumn	3
32	3	0.1439	0	Winter	ovx	Autumn	3
32	3	0.1444	0	Winter	ovx	Autumn	3
32	3	0.1450	0	Winter	ovx	Autumn	3
32	3	0.1455	0	Winter	ovx	Autumn	3
32	3	0.1461	0	Winter	ovx	Autumn	3
32	4	0.0059	0	Winter	ovx	Autumn	3
32	4	0.0114	0	Winter	ovx	Autumn	3
32	4	0.0158	0	Winter	ovx	Autumn	3
32	4	0.0196	0	Winter	ovx	Autumn	3
32	4	0.0228	0	Winter	ovx	Autumn	3
32	4	0.0257	0	Winter	ovx	Autumn	3
32	4	0.0283	0	Winter	ovx	Autumn	3
32	4	0.0306	0	Winter	ovx	Autumn	3
32	4	0.0327	0	Winter	ovx	Autumn	3
32	4	0.0347	0	Winter	ovx	Autumn	3
32	4	0.0365	0	Winter	ovx	Autumn	3
32	4	0.0382	0	Winter	ovx	Autumn	3
32	4	0.0398	0	Winter	ovx	Autumn	3
32	4	0.0413	0	Winter	ovx	Autumn	3
32	4	0.0427	0	Winter	ovx	Autumn	3
32	4	0.0441	0	Winter	ovx	Autumn	3
32	4	0.0454	0	Winter	ovx	Autumn	3
32	4	0.0466	0	Winter	ovx	Autumn	3
32	4	0.0478	0	Winter	ovx	Autumn	3
32	4	0.0489	11144	Winter	ovx	Autumn	3
32	4	0.0500	13814	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	4	0.0510	14646	Winter	ovx	Autumn	3
32	4	0.0520	17945	Winter	ovx	Autumn	3
32	4	0.0530	19078	Winter	ovx	Autumn	3
32	4	0.0539	21935	Winter	ovx	Autumn	3
32	4	0.0548	24766	Winter	ovx	Autumn	3
32	4	0.0557	26562	Winter	ovx	Autumn	3
32	4	0.0566	30628	Winter	ovx	Autumn	3
32	4	0.0574	32616	Winter	ovx	Autumn	3
32	4	0.0582	35371	Winter	ovx	Autumn	3
32	4	0.0590	38245	Winter	ovx	Autumn	3
32	4	0.0597	40036	Winter	ovx	Autumn	3
32	4	0.0605	44511	Winter	ovx	Autumn	3
32	4	0.0612	47132	Winter	ovx	Autumn	3
32	4	0.0619	52152	Winter	ovx	Autumn	3
32	4	0.0626	58111	Winter	ovx	Autumn	3
32	4	0.0633	60684	Winter	ovx	Autumn	3
32	4	0.0640	68966	Winter	ovx	Autumn	3
32	4	0.0646	72198	Winter	ovx	Autumn	3
32	4	0.0652	76608	Winter	ovx	Autumn	3
32	4	0.0659	82691	Winter	ovx	Autumn	3
32	4	0.0665	85611	Winter	ovx	Autumn	3
32	4	0.0671	90364	Winter	ovx	Autumn	3
32	4	0.0677	93316	Winter	ovx	Autumn	3
32	4	0.0683	97079	Winter	ovx	Autumn	3
32	4	0.0688	101647	Winter	ovx	Autumn	3
32	4	0.0694	103892	Winter	ovx	Autumn	3
32	4	0.0699	109718	Winter	ovx	Autumn	3
32	4	0.0705	114454	Winter	ovx	Autumn	3
32	4	0.0710	120238	Winter	ovx	Autumn	3
32	4	0.0716	127381	Winter	ovx	Autumn	3
32	4	0.0721	132316	Winter	ovx	Autumn	3
32	4	0.0726	138104	Winter	ovx	Autumn	3
32	4	0.0731	144987	Winter	ovx	Autumn	3
32	4	0.0736	150877	Winter	ovx	Autumn	3
32	4	0.0741	159154	Winter	ovx	Autumn	3
32	4	0.0746	163927	Winter	ovx	Autumn	3
32	4	0.0751	168968	Winter	ovx	Autumn	3
32	4	0.0755	173279	Winter	ovx	Autumn	3
32	4	0.0760	175241	Winter	ovx	Autumn	3
32	4	0.0765	176295	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	4	0.0769	176818	Winter	ovx	Autumn	3
32	4	0.0774	174052	Winter	ovx	Autumn	3
32	4	0.0778	170906	Winter	ovx	Autumn	3
32	4	0.0783	165575	Winter	ovx	Autumn	3
32	4	0.0787	155699	Winter	ovx	Autumn	3
32	4	0.0791	146204	Winter	ovx	Autumn	3
32	4	0.0796	135272	Winter	ovx	Autumn	3
32	4	0.0800	123282	Winter	ovx	Autumn	3
32	4	0.0804	111163	Winter	ovx	Autumn	3
32	4	0.0808	100067	Winter	ovx	Autumn	3
32	4	0.0812	89294	Winter	ovx	Autumn	3
32	4	0.0816	78344	Winter	ovx	Autumn	3
32	4	0.0820	68939	Winter	ovx	Autumn	3
32	4	0.0824	59728	Winter	ovx	Autumn	3
32	4	0.0828	51766	Winter	ovx	Autumn	3
32	4	0.0832	44429	Winter	ovx	Autumn	3
32	4	0.0836	37560	Winter	ovx	Autumn	3
32	4	0.0840	31517	Winter	ovx	Autumn	3
32	4	0.0844	26599	Winter	ovx	Autumn	3
32	4	0.0848	21974	Winter	ovx	Autumn	3
32	4	0.0852	18696	Winter	ovx	Autumn	3
32	4	0.0855	15335	Winter	ovx	Autumn	3
32	4	0.0859	13007	Winter	ovx	Autumn	3
32	4	0.0863	10658	Winter	ovx	Autumn	3
32	4	0.0867	9035	Winter	ovx	Autumn	3
32	4	0.0870	7519	Winter	ovx	Autumn	3
32	4	0.0874	6233	Winter	ovx	Autumn	3
32	4	0.0878	5109	Winter	ovx	Autumn	3
32	4	0.0881	4226	Winter	ovx	Autumn	3
32	4	0.0885	3646	Winter	ovx	Autumn	3
32	4	0.0888	2866	Winter	ovx	Autumn	3
32	4	0.0892	2356	Winter	ovx	Autumn	3
32	4	0.0895	2017	Winter	ovx	Autumn	3
32	4	0.0899	1666	Winter	ovx	Autumn	3
32	4	0.0902	1348	Winter	ovx	Autumn	3
32	4	0.0906	1123	Winter	ovx	Autumn	3
32	4	0.0909	902	Winter	ovx	Autumn	3
32	4	0.0913	692	Winter	ovx	Autumn	3
32	4	0.0916	561	Winter	ovx	Autumn	3
32	4	0.0919	477	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	4	0.0923	399	Winter	ovx	Autumn	3
32	4	0.0926	314	Winter	ovx	Autumn	3
32	4	0.0930	240	Winter	ovx	Autumn	3
32	4	0.0933	192	Winter	ovx	Autumn	3
32	4	0.0936	167	Winter	ovx	Autumn	3
32	4	0.0939	114	Winter	ovx	Autumn	3
32	4	0.0943	97	Winter	ovx	Autumn	3
32	4	0.0946	65	Winter	ovx	Autumn	3
32	4	0.0949	69	Winter	ovx	Autumn	3
32	4	0.0953	65	Winter	ovx	Autumn	3
32	4	0.0956	34	Winter	ovx	Autumn	3
32	4	0.0959	35	Winter	ovx	Autumn	3
32	4	0.0962	33	Winter	ovx	Autumn	3
32	4	0.0965	26	Winter	ovx	Autumn	3
32	4	0.0969	22	Winter	ovx	Autumn	3
32	4	0.0972	15	Winter	ovx	Autumn	3
32	4	0.0975	21	Winter	ovx	Autumn	3
32	4	0.0978	10	Winter	ovx	Autumn	3
32	4	0.0981	8	Winter	ovx	Autumn	3
32	4	0.0984	7	Winter	ovx	Autumn	3
32	4	0.0988	12	Winter	ovx	Autumn	3
32	4	0.0991	10	Winter	ovx	Autumn	3
32	4	0.0994	10	Winter	ovx	Autumn	3
32	4	0.0997	10	Winter	ovx	Autumn	3
32	4	0.1000	4	Winter	ovx	Autumn	3
32	4	0.1003	9	Winter	ovx	Autumn	3
32	4	0.1006	3	Winter	ovx	Autumn	3
32	4	0.1009	10	Winter	ovx	Autumn	3
32	4	0.1012	4	Winter	ovx	Autumn	3
32	4	0.1015	7	Winter	ovx	Autumn	3
32	4	0.1018	3	Winter	ovx	Autumn	3
32	4	0.1022	2	Winter	ovx	Autumn	3
32	4	0.1025	4	Winter	ovx	Autumn	3
32	4	0.1028	7	Winter	ovx	Autumn	3
32	4	0.1031	2	Winter	ovx	Autumn	3
32	4	0.1034	4	Winter	ovx	Autumn	3
32	4	0.1037	4	Winter	ovx	Autumn	3
32	4	0.1040	2	Winter	ovx	Autumn	3
32	4	0.1043	0	Winter	ovx	Autumn	3
32	4	0.1046	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	4	0.1049	3	Winter	ovx	Autumn	3
32	4	0.1052	1	Winter	ovx	Autumn	3
32	4	0.1055	0	Winter	ovx	Autumn	3
32	4	0.1058	0	Winter	ovx	Autumn	3
32	4	0.1061	2	Winter	ovx	Autumn	3
32	4	0.1064	0	Winter	ovx	Autumn	3
32	4	0.1067	1	Winter	ovx	Autumn	3
32	4	0.1070	0	Winter	ovx	Autumn	3
32	4	0.1073	0	Winter	ovx	Autumn	3
32	4	0.1076	0	Winter	ovx	Autumn	3
32	4	0.1079	1	Winter	ovx	Autumn	3
32	4	0.1082	0	Winter	ovx	Autumn	3
32	4	0.1085	3	Winter	ovx	Autumn	3
32	4	0.1088	0	Winter	ovx	Autumn	3
32	4	0.1091	1	Winter	ovx	Autumn	3
32	4	0.1094	0	Winter	ovx	Autumn	3
32	4	0.1097	0	Winter	ovx	Autumn	3
32	4	0.1100	1	Winter	ovx	Autumn	3
32	4	0.1103	0	Winter	ovx	Autumn	3
32	4	0.1106	1	Winter	ovx	Autumn	3
32	4	0.1109	0	Winter	ovx	Autumn	3
32	4	0.1112	0	Winter	ovx	Autumn	3
32	4	0.1115	0	Winter	ovx	Autumn	3
32	4	0.1118	1	Winter	ovx	Autumn	3
32	4	0.1122	0	Winter	ovx	Autumn	3
32	4	0.1125	0	Winter	ovx	Autumn	3
32	4	0.1128	1	Winter	ovx	Autumn	3
32	4	0.1131	0	Winter	ovx	Autumn	3
32	4	0.1134	0	Winter	ovx	Autumn	3
32	4	0.1137	0	Winter	ovx	Autumn	3
32	4	0.1140	0	Winter	ovx	Autumn	3
32	4	0.1143	1	Winter	ovx	Autumn	3
32	4	0.1146	0	Winter	ovx	Autumn	3
32	4	0.1149	0	Winter	ovx	Autumn	3
32	4	0.1152	0	Winter	ovx	Autumn	3
32	4	0.1155	1	Winter	ovx	Autumn	3
32	4	0.1158	0	Winter	ovx	Autumn	3
32	4	0.1161	1	Winter	ovx	Autumn	3
32	4	0.1165	0	Winter	ovx	Autumn	3
32	4	0.1168	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	4	0.1171	0	Winter	ovx	Autumn	3
32	4	0.1174	0	Winter	ovx	Autumn	3
32	4	0.1177	1	Winter	ovx	Autumn	3
32	4	0.1180	0	Winter	ovx	Autumn	3
32	4	0.1183	0	Winter	ovx	Autumn	3
32	4	0.1187	1	Winter	ovx	Autumn	3
32	4	0.1190	0	Winter	ovx	Autumn	3
32	4	0.1193	0	Winter	ovx	Autumn	3
32	4	0.1196	0	Winter	ovx	Autumn	3
32	4	0.1199	0	Winter	ovx	Autumn	3
32	4	0.1203	0	Winter	ovx	Autumn	3
32	4	0.1206	0	Winter	ovx	Autumn	3
32	4	0.1209	0	Winter	ovx	Autumn	3
32	4	0.1212	0	Winter	ovx	Autumn	3
32	4	0.1216	0	Winter	ovx	Autumn	3
32	4	0.1219	0	Winter	ovx	Autumn	3
32	4	0.1222	0	Winter	ovx	Autumn	3
32	4	0.1226	0	Winter	ovx	Autumn	3
32	4	0.1229	0	Winter	ovx	Autumn	3
32	4	0.1232	0	Winter	ovx	Autumn	3
32	4	0.1236	0	Winter	ovx	Autumn	3
32	4	0.1239	0	Winter	ovx	Autumn	3
32	4	0.1243	0	Winter	ovx	Autumn	3
32	4	0.1246	0	Winter	ovx	Autumn	3
32	4	0.1249	0	Winter	ovx	Autumn	3
32	4	0.1253	0	Winter	ovx	Autumn	3
32	4	0.1256	0	Winter	ovx	Autumn	3
32	4	0.1260	0	Winter	ovx	Autumn	3
32	4	0.1263	0	Winter	ovx	Autumn	3
32	4	0.1267	0	Winter	ovx	Autumn	3
32	4	0.1270	0	Winter	ovx	Autumn	3
32	4	0.1274	0	Winter	ovx	Autumn	3
32	4	0.1278	0	Winter	ovx	Autumn	3
32	4	0.1281	0	Winter	ovx	Autumn	3
32	4	0.1285	0	Winter	ovx	Autumn	3
32	4	0.1288	0	Winter	ovx	Autumn	3
32	4	0.1292	0	Winter	ovx	Autumn	3
32	4	0.1296	0	Winter	ovx	Autumn	3
32	4	0.1300	0	Winter	ovx	Autumn	3
32	4	0.1303	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	4	0.1307	0	Winter	ovx	Autumn	3
32	4	0.1311	0	Winter	ovx	Autumn	3
32	4	0.1315	0	Winter	ovx	Autumn	3
32	4	0.1319	0	Winter	ovx	Autumn	3
32	4	0.1323	0	Winter	ovx	Autumn	3
32	4	0.1327	0	Winter	ovx	Autumn	3
32	4	0.1331	0	Winter	ovx	Autumn	3
32	4	0.1335	0	Winter	ovx	Autumn	3
32	4	0.1339	0	Winter	ovx	Autumn	3
32	4	0.1343	0	Winter	ovx	Autumn	3
32	4	0.1347	0	Winter	ovx	Autumn	3
32	4	0.1351	0	Winter	ovx	Autumn	3
32	4	0.1355	0	Winter	ovx	Autumn	3
32	4	0.1359	0	Winter	ovx	Autumn	3
32	4	0.1364	0	Winter	ovx	Autumn	3
32	4	0.1368	0	Winter	ovx	Autumn	3
32	4	0.1372	0	Winter	ovx	Autumn	3
32	4	0.1377	0	Winter	ovx	Autumn	3
32	4	0.1381	0	Winter	ovx	Autumn	3
32	4	0.1386	0	Winter	ovx	Autumn	3
32	4	0.1390	0	Winter	ovx	Autumn	3
32	4	0.1395	0	Winter	ovx	Autumn	3
32	4	0.1400	0	Winter	ovx	Autumn	3
32	4	0.1404	0	Winter	ovx	Autumn	3
32	4	0.1409	0	Winter	ovx	Autumn	3
32	4	0.1414	0	Winter	ovx	Autumn	3
32	4	0.1419	0	Winter	ovx	Autumn	3
32	4	0.1424	0	Winter	ovx	Autumn	3
32	4	0.1429	0	Winter	ovx	Autumn	3
32	4	0.1434	0	Winter	ovx	Autumn	3
32	4	0.1439	0	Winter	ovx	Autumn	3
32	4	0.1444	0	Winter	ovx	Autumn	3
32	4	0.1450	0	Winter	ovx	Autumn	3
32	4	0.1455	0	Winter	ovx	Autumn	3
32	4	0.1461	0	Winter	ovx	Autumn	3
32	5	0.0059	0	Winter	ovx	Autumn	3
32	5	0.0114	0	Winter	ovx	Autumn	3
32	5	0.0158	0	Winter	ovx	Autumn	3
32	5	0.0196	0	Winter	ovx	Autumn	3
32	5	0.0228	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.0257	0	Winter	ovx	Autumn	3
32	5	0.0283	0	Winter	ovx	Autumn	3
32	5	0.0306	0	Winter	ovx	Autumn	3
32	5	0.0327	0	Winter	ovx	Autumn	3
32	5	0.0347	0	Winter	ovx	Autumn	3
32	5	0.0365	0	Winter	ovx	Autumn	3
32	5	0.0382	0	Winter	ovx	Autumn	3
32	5	0.0398	0	Winter	ovx	Autumn	3
32	5	0.0413	0	Winter	ovx	Autumn	3
32	5	0.0427	0	Winter	ovx	Autumn	3
32	5	0.0441	0	Winter	ovx	Autumn	3
32	5	0.0454	0	Winter	ovx	Autumn	3
32	5	0.0466	27203	Winter	ovx	Autumn	3
32	5	0.0478	31484	Winter	ovx	Autumn	3
32	5	0.0489	40753	Winter	ovx	Autumn	3
32	5	0.0500	53612	Winter	ovx	Autumn	3
32	5	0.0510	54038	Winter	ovx	Autumn	3
32	5	0.0520	61251	Winter	ovx	Autumn	3
32	5	0.0530	65976	Winter	ovx	Autumn	3
32	5	0.0539	72619	Winter	ovx	Autumn	3
32	5	0.0548	80420	Winter	ovx	Autumn	3
32	5	0.0557	85184	Winter	ovx	Autumn	3
32	5	0.0566	95544	Winter	ovx	Autumn	3
32	5	0.0574	99971	Winter	ovx	Autumn	3
32	5	0.0582	103350	Winter	ovx	Autumn	3
32	5	0.0590	110691	Winter	ovx	Autumn	3
32	5	0.0597	110540	Winter	ovx	Autumn	3
32	5	0.0605	116731	Winter	ovx	Autumn	3
32	5	0.0612	120268	Winter	ovx	Autumn	3
32	5	0.0619	125089	Winter	ovx	Autumn	3
32	5	0.0626	131077	Winter	ovx	Autumn	3
32	5	0.0633	133029	Winter	ovx	Autumn	3
32	5	0.0640	140974	Winter	ovx	Autumn	3
32	5	0.0646	142326	Winter	ovx	Autumn	3
32	5	0.0652	143638	Winter	ovx	Autumn	3
32	5	0.0659	146087	Winter	ovx	Autumn	3
32	5	0.0665	147095	Winter	ovx	Autumn	3
32	5	0.0671	148052	Winter	ovx	Autumn	3
32	5	0.0677	148465	Winter	ovx	Autumn	3
32	5	0.0683	148663	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.0688	147738	Winter	ovx	Autumn	3
32	5	0.0694	147632	Winter	ovx	Autumn	3
32	5	0.0699	149549	Winter	ovx	Autumn	3
32	5	0.0705	149547	Winter	ovx	Autumn	3
32	5	0.0710	149169	Winter	ovx	Autumn	3
32	5	0.0716	149509	Winter	ovx	Autumn	3
32	5	0.0721	147535	Winter	ovx	Autumn	3
32	5	0.0726	144579	Winter	ovx	Autumn	3
32	5	0.0731	140308	Winter	ovx	Autumn	3
32	5	0.0736	135194	Winter	ovx	Autumn	3
32	5	0.0741	128853	Winter	ovx	Autumn	3
32	5	0.0746	121522	Winter	ovx	Autumn	3
32	5	0.0751	112021	Winter	ovx	Autumn	3
32	5	0.0755	103278	Winter	ovx	Autumn	3
32	5	0.0760	93125	Winter	ovx	Autumn	3
32	5	0.0765	83381	Winter	ovx	Autumn	3
32	5	0.0769	73285	Winter	ovx	Autumn	3
32	5	0.0774	65129	Winter	ovx	Autumn	3
32	5	0.0778	56163	Winter	ovx	Autumn	3
32	5	0.0783	48352	Winter	ovx	Autumn	3
32	5	0.0787	40881	Winter	ovx	Autumn	3
32	5	0.0791	34300	Winter	ovx	Autumn	3
32	5	0.0796	28248	Winter	ovx	Autumn	3
32	5	0.0800	23307	Winter	ovx	Autumn	3
32	5	0.0804	18478	Winter	ovx	Autumn	3
32	5	0.0808	15190	Winter	ovx	Autumn	3
32	5	0.0812	12261	Winter	ovx	Autumn	3
32	5	0.0816	9721	Winter	ovx	Autumn	3
32	5	0.0820	7868	Winter	ovx	Autumn	3
32	5	0.0824	6140	Winter	ovx	Autumn	3
32	5	0.0828	4784	Winter	ovx	Autumn	3
32	5	0.0832	3800	Winter	ovx	Autumn	3
32	5	0.0836	3074	Winter	ovx	Autumn	3
32	5	0.0840	2467	Winter	ovx	Autumn	3
32	5	0.0844	1929	Winter	ovx	Autumn	3
32	5	0.0848	1483	Winter	ovx	Autumn	3
32	5	0.0852	1143	Winter	ovx	Autumn	3
32	5	0.0855	897	Winter	ovx	Autumn	3
32	5	0.0859	724	Winter	ovx	Autumn	3
32	5	0.0863	571	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.0867	463	Winter	ovx	Autumn	3
32	5	0.0870	379	Winter	ovx	Autumn	3
32	5	0.0874	311	Winter	ovx	Autumn	3
32	5	0.0878	206	Winter	ovx	Autumn	3
32	5	0.0881	211	Winter	ovx	Autumn	3
32	5	0.0885	178	Winter	ovx	Autumn	3
32	5	0.0888	126	Winter	ovx	Autumn	3
32	5	0.0892	101	Winter	ovx	Autumn	3
32	5	0.0895	98	Winter	ovx	Autumn	3
32	5	0.0899	70	Winter	ovx	Autumn	3
32	5	0.0902	62	Winter	ovx	Autumn	3
32	5	0.0906	41	Winter	ovx	Autumn	3
32	5	0.0909	36	Winter	ovx	Autumn	3
32	5	0.0913	34	Winter	ovx	Autumn	3
32	5	0.0916	24	Winter	ovx	Autumn	3
32	5	0.0919	29	Winter	ovx	Autumn	3
32	5	0.0923	22	Winter	ovx	Autumn	3
32	5	0.0926	25	Winter	ovx	Autumn	3
32	5	0.0930	20	Winter	ovx	Autumn	3
32	5	0.0933	16	Winter	ovx	Autumn	3
32	5	0.0936	20	Winter	ovx	Autumn	3
32	5	0.0939	19	Winter	ovx	Autumn	3
32	5	0.0943	12	Winter	ovx	Autumn	3
32	5	0.0946	13	Winter	ovx	Autumn	3
32	5	0.0949	10	Winter	ovx	Autumn	3
32	5	0.0953	9	Winter	ovx	Autumn	3
32	5	0.0956	9	Winter	ovx	Autumn	3
32	5	0.0959	10	Winter	ovx	Autumn	3
32	5	0.0962	7	Winter	ovx	Autumn	3
32	5	0.0965	19	Winter	ovx	Autumn	3
32	5	0.0969	12	Winter	ovx	Autumn	3
32	5	0.0972	8	Winter	ovx	Autumn	3
32	5	0.0975	10	Winter	ovx	Autumn	3
32	5	0.0978	11	Winter	ovx	Autumn	3
32	5	0.0981	8	Winter	ovx	Autumn	3
32	5	0.0984	10	Winter	ovx	Autumn	3
32	5	0.0988	3	Winter	ovx	Autumn	3
32	5	0.0991	10	Winter	ovx	Autumn	3
32	5	0.0994	4	Winter	ovx	Autumn	3
32	5	0.0997	6	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.1000	5	Winter	ovx	Autumn	3
32	5	0.1003	7	Winter	ovx	Autumn	3
32	5	0.1006	8	Winter	ovx	Autumn	3
32	5	0.1009	2	Winter	ovx	Autumn	3
32	5	0.1012	5	Winter	ovx	Autumn	3
32	5	0.1015	1	Winter	ovx	Autumn	3
32	5	0.1018	5	Winter	ovx	Autumn	3
32	5	0.1022	4	Winter	ovx	Autumn	3
32	5	0.1025	7	Winter	ovx	Autumn	3
32	5	0.1028	7	Winter	ovx	Autumn	3
32	5	0.1031	6	Winter	ovx	Autumn	3
32	5	0.1034	4	Winter	ovx	Autumn	3
32	5	0.1037	3	Winter	ovx	Autumn	3
32	5	0.1040	3	Winter	ovx	Autumn	3
32	5	0.1043	2	Winter	ovx	Autumn	3
32	5	0.1046	3	Winter	ovx	Autumn	3
32	5	0.1049	1	Winter	ovx	Autumn	3
32	5	0.1052	1	Winter	ovx	Autumn	3
32	5	0.1055	4	Winter	ovx	Autumn	3
32	5	0.1058	3	Winter	ovx	Autumn	3
32	5	0.1061	2	Winter	ovx	Autumn	3
32	5	0.1064	3	Winter	ovx	Autumn	3
32	5	0.1067	1	Winter	ovx	Autumn	3
32	5	0.1070	4	Winter	ovx	Autumn	3
32	5	0.1073	0	Winter	ovx	Autumn	3
32	5	0.1076	1	Winter	ovx	Autumn	3
32	5	0.1079	4	Winter	ovx	Autumn	3
32	5	0.1082	0	Winter	ovx	Autumn	3
32	5	0.1085	6	Winter	ovx	Autumn	3
32	5	0.1088	4	Winter	ovx	Autumn	3
32	5	0.1091	1	Winter	ovx	Autumn	3
32	5	0.1094	1	Winter	ovx	Autumn	3
32	5	0.1097	1	Winter	ovx	Autumn	3
32	5	0.1100	2	Winter	ovx	Autumn	3
32	5	0.1103	0	Winter	ovx	Autumn	3
32	5	0.1106	1	Winter	ovx	Autumn	3
32	5	0.1109	2	Winter	ovx	Autumn	3
32	5	0.1112	1	Winter	ovx	Autumn	3
32	5	0.1115	2	Winter	ovx	Autumn	3
32	5	0.1118	3	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.1122	2	Winter	ovx	Autumn	3
32	5	0.1125	0	Winter	ovx	Autumn	3
32	5	0.1128	0	Winter	ovx	Autumn	3
32	5	0.1131	0	Winter	ovx	Autumn	3
32	5	0.1134	1	Winter	ovx	Autumn	3
32	5	0.1137	0	Winter	ovx	Autumn	3
32	5	0.1140	0	Winter	ovx	Autumn	3
32	5	0.1143	0	Winter	ovx	Autumn	3
32	5	0.1146	2	Winter	ovx	Autumn	3
32	5	0.1149	1	Winter	ovx	Autumn	3
32	5	0.1152	1	Winter	ovx	Autumn	3
32	5	0.1155	0	Winter	ovx	Autumn	3
32	5	0.1158	0	Winter	ovx	Autumn	3
32	5	0.1161	0	Winter	ovx	Autumn	3
32	5	0.1165	0	Winter	ovx	Autumn	3
32	5	0.1168	0	Winter	ovx	Autumn	3
32	5	0.1171	0	Winter	ovx	Autumn	3
32	5	0.1174	0	Winter	ovx	Autumn	3
32	5	0.1177	1	Winter	ovx	Autumn	3
32	5	0.1180	0	Winter	ovx	Autumn	3
32	5	0.1183	1	Winter	ovx	Autumn	3
32	5	0.1187	1	Winter	ovx	Autumn	3
32	5	0.1190	0	Winter	ovx	Autumn	3
32	5	0.1193	0	Winter	ovx	Autumn	3
32	5	0.1196	0	Winter	ovx	Autumn	3
32	5	0.1199	0	Winter	ovx	Autumn	3
32	5	0.1203	0	Winter	ovx	Autumn	3
32	5	0.1206	0	Winter	ovx	Autumn	3
32	5	0.1209	0	Winter	ovx	Autumn	3
32	5	0.1212	1	Winter	ovx	Autumn	3
32	5	0.1216	0	Winter	ovx	Autumn	3
32	5	0.1219	0	Winter	ovx	Autumn	3
32	5	0.1222	0	Winter	ovx	Autumn	3
32	5	0.1226	0	Winter	ovx	Autumn	3
32	5	0.1229	0	Winter	ovx	Autumn	3
32	5	0.1232	0	Winter	ovx	Autumn	3
32	5	0.1236	0	Winter	ovx	Autumn	3
32	5	0.1239	0	Winter	ovx	Autumn	3
32	5	0.1243	0	Winter	ovx	Autumn	3
32	5	0.1246	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.1249	0	Winter	ovx	Autumn	3
32	5	0.1253	0	Winter	ovx	Autumn	3
32	5	0.1256	0	Winter	ovx	Autumn	3
32	5	0.1260	0	Winter	ovx	Autumn	3
32	5	0.1263	0	Winter	ovx	Autumn	3
32	5	0.1267	0	Winter	ovx	Autumn	3
32	5	0.1270	0	Winter	ovx	Autumn	3
32	5	0.1274	0	Winter	ovx	Autumn	3
32	5	0.1278	0	Winter	ovx	Autumn	3
32	5	0.1281	0	Winter	ovx	Autumn	3
32	5	0.1285	0	Winter	ovx	Autumn	3
32	5	0.1288	0	Winter	ovx	Autumn	3
32	5	0.1292	0	Winter	ovx	Autumn	3
32	5	0.1296	0	Winter	ovx	Autumn	3
32	5	0.1300	0	Winter	ovx	Autumn	3
32	5	0.1303	0	Winter	ovx	Autumn	3
32	5	0.1307	0	Winter	ovx	Autumn	3
32	5	0.1311	0	Winter	ovx	Autumn	3
32	5	0.1315	0	Winter	ovx	Autumn	3
32	5	0.1319	0	Winter	ovx	Autumn	3
32	5	0.1323	0	Winter	ovx	Autumn	3
32	5	0.1327	0	Winter	ovx	Autumn	3
32	5	0.1331	0	Winter	ovx	Autumn	3
32	5	0.1335	0	Winter	ovx	Autumn	3
32	5	0.1339	0	Winter	ovx	Autumn	3
32	5	0.1343	0	Winter	ovx	Autumn	3
32	5	0.1347	0	Winter	ovx	Autumn	3
32	5	0.1351	0	Winter	ovx	Autumn	3
32	5	0.1355	0	Winter	ovx	Autumn	3
32	5	0.1359	0	Winter	ovx	Autumn	3
32	5	0.1364	0	Winter	ovx	Autumn	3
32	5	0.1368	0	Winter	ovx	Autumn	3
32	5	0.1372	0	Winter	ovx	Autumn	3
32	5	0.1377	0	Winter	ovx	Autumn	3
32	5	0.1381	0	Winter	ovx	Autumn	3
32	5	0.1386	0	Winter	ovx	Autumn	3
32	5	0.1390	0	Winter	ovx	Autumn	3
32	5	0.1395	0	Winter	ovx	Autumn	3
32	5	0.1400	0	Winter	ovx	Autumn	3
32	5	0.1404	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	5	0.1409	0	Winter	ovx	Autumn	3
32	5	0.1414	0	Winter	ovx	Autumn	3
32	5	0.1419	0	Winter	ovx	Autumn	3
32	5	0.1424	0	Winter	ovx	Autumn	3
32	5	0.1429	0	Winter	ovx	Autumn	3
32	5	0.1434	0	Winter	ovx	Autumn	3
32	5	0.1439	0	Winter	ovx	Autumn	3
32	5	0.1444	0	Winter	ovx	Autumn	3
32	5	0.1450	0	Winter	ovx	Autumn	3
32	5	0.1455	0	Winter	ovx	Autumn	3
32	5	0.1461	0	Winter	ovx	Autumn	3
32	6	0.0059	0	Winter	ovx	Autumn	3
32	6	0.0114	0	Winter	ovx	Autumn	3
32	6	0.0158	0	Winter	ovx	Autumn	3
32	6	0.0196	0	Winter	ovx	Autumn	3
32	6	0.0228	0	Winter	ovx	Autumn	3
32	6	0.0257	0	Winter	ovx	Autumn	3
32	6	0.0283	0	Winter	ovx	Autumn	3
32	6	0.0306	0	Winter	ovx	Autumn	3
32	6	0.0327	0	Winter	ovx	Autumn	3
32	6	0.0347	0	Winter	ovx	Autumn	3
32	6	0.0365	0	Winter	ovx	Autumn	3
32	6	0.0382	0	Winter	ovx	Autumn	3
32	6	0.0398	0	Winter	ovx	Autumn	3
32	6	0.0413	0	Winter	ovx	Autumn	3
32	6	0.0427	0	Winter	ovx	Autumn	3
32	6	0.0441	0	Winter	ovx	Autumn	3
32	6	0.0454	0	Winter	ovx	Autumn	3
32	6	0.0466	0	Winter	ovx	Autumn	3
32	6	0.0478	0	Winter	ovx	Autumn	3
32	6	0.0489	22519	Winter	ovx	Autumn	3
32	6	0.0500	30978	Winter	ovx	Autumn	3
32	6	0.0510	32352	Winter	ovx	Autumn	3
32	6	0.0520	40115	Winter	ovx	Autumn	3
32	6	0.0530	47263	Winter	ovx	Autumn	3
32	6	0.0539	52226	Winter	ovx	Autumn	3
32	6	0.0548	59316	Winter	ovx	Autumn	3
32	6	0.0557	64123	Winter	ovx	Autumn	3
32	6	0.0566	73234	Winter	ovx	Autumn	3
32	6	0.0574	79068	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	6	0.0582	83601	Winter	ovx	Autumn	3
32	6	0.0590	93879	Winter	ovx	Autumn	3
32	6	0.0597	98451	Winter	ovx	Autumn	3
32	6	0.0605	106472	Winter	ovx	Autumn	3
32	6	0.0612	115486	Winter	ovx	Autumn	3
32	6	0.0619	123694	Winter	ovx	Autumn	3
32	6	0.0626	133469	Winter	ovx	Autumn	3
32	6	0.0633	139098	Winter	ovx	Autumn	3
32	6	0.0640	148124	Winter	ovx	Autumn	3
32	6	0.0646	151895	Winter	ovx	Autumn	3
32	6	0.0652	155370	Winter	ovx	Autumn	3
32	6	0.0659	160935	Winter	ovx	Autumn	3
32	6	0.0665	164414	Winter	ovx	Autumn	3
32	6	0.0671	169388	Winter	ovx	Autumn	3
32	6	0.0677	173599	Winter	ovx	Autumn	3
32	6	0.0683	176183	Winter	ovx	Autumn	3
32	6	0.0688	179365	Winter	ovx	Autumn	3
32	6	0.0694	182691	Winter	ovx	Autumn	3
32	6	0.0699	186967	Winter	ovx	Autumn	3
32	6	0.0705	190430	Winter	ovx	Autumn	3
32	6	0.0710	194267	Winter	ovx	Autumn	3
32	6	0.0716	194927	Winter	ovx	Autumn	3
32	6	0.0721	192921	Winter	ovx	Autumn	3
32	6	0.0726	186718	Winter	ovx	Autumn	3
32	6	0.0731	178421	Winter	ovx	Autumn	3
32	6	0.0736	167897	Winter	ovx	Autumn	3
32	6	0.0741	154661	Winter	ovx	Autumn	3
32	6	0.0746	140582	Winter	ovx	Autumn	3
32	6	0.0751	125073	Winter	ovx	Autumn	3
32	6	0.0755	108662	Winter	ovx	Autumn	3
32	6	0.0760	94193	Winter	ovx	Autumn	3
32	6	0.0765	79274	Winter	ovx	Autumn	3
32	6	0.0769	66323	Winter	ovx	Autumn	3
32	6	0.0774	55382	Winter	ovx	Autumn	3
32	6	0.0778	45194	Winter	ovx	Autumn	3
32	6	0.0783	36594	Winter	ovx	Autumn	3
32	6	0.0787	29331	Winter	ovx	Autumn	3
32	6	0.0791	23491	Winter	ovx	Autumn	3
32	6	0.0796	18520	Winter	ovx	Autumn	3
32	6	0.0800	14572	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	6	0.0804	11419	Winter	ovx	Autumn	3
32	6	0.0808	9019	Winter	ovx	Autumn	3
32	6	0.0812	6937	Winter	ovx	Autumn	3
32	6	0.0816	5413	Winter	ovx	Autumn	3
32	6	0.0820	4328	Winter	ovx	Autumn	3
32	6	0.0824	3250	Winter	ovx	Autumn	3
32	6	0.0828	2611	Winter	ovx	Autumn	3
32	6	0.0832	2038	Winter	ovx	Autumn	3
32	6	0.0836	1573	Winter	ovx	Autumn	3
32	6	0.0840	1213	Winter	ovx	Autumn	3
32	6	0.0844	959	Winter	ovx	Autumn	3
32	6	0.0848	706	Winter	ovx	Autumn	3
32	6	0.0852	552	Winter	ovx	Autumn	3
32	6	0.0855	472	Winter	ovx	Autumn	3
32	6	0.0859	326	Winter	ovx	Autumn	3
32	6	0.0863	224	Winter	ovx	Autumn	3
32	6	0.0867	176	Winter	ovx	Autumn	3
32	6	0.0870	143	Winter	ovx	Autumn	3
32	6	0.0874	111	Winter	ovx	Autumn	3
32	6	0.0878	71	Winter	ovx	Autumn	3
32	6	0.0881	81	Winter	ovx	Autumn	3
32	6	0.0885	51	Winter	ovx	Autumn	3
32	6	0.0888	33	Winter	ovx	Autumn	3
32	6	0.0892	18	Winter	ovx	Autumn	3
32	6	0.0895	20	Winter	ovx	Autumn	3
32	6	0.0899	10	Winter	ovx	Autumn	3
32	6	0.0902	10	Winter	ovx	Autumn	3
32	6	0.0906	8	Winter	ovx	Autumn	3
32	6	0.0909	7	Winter	ovx	Autumn	3
32	6	0.0913	11	Winter	ovx	Autumn	3
32	6	0.0916	2	Winter	ovx	Autumn	3
32	6	0.0919	6	Winter	ovx	Autumn	3
32	6	0.0923	8	Winter	ovx	Autumn	3
32	6	0.0926	6	Winter	ovx	Autumn	3
32	6	0.0930	2	Winter	ovx	Autumn	3
32	6	0.0933	5	Winter	ovx	Autumn	3
32	6	0.0936	3	Winter	ovx	Autumn	3
32	6	0.0939	2	Winter	ovx	Autumn	3
32	6	0.0943	1	Winter	ovx	Autumn	3
32	6	0.0946	2	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	6	0.0949	4	Winter	ovx	Autumn	3
32	6	0.0953	2	Winter	ovx	Autumn	3
32	6	0.0956	3	Winter	ovx	Autumn	3
32	6	0.0959	2	Winter	ovx	Autumn	3
32	6	0.0962	4	Winter	ovx	Autumn	3
32	6	0.0965	1	Winter	ovx	Autumn	3
32	6	0.0969	1	Winter	ovx	Autumn	3
32	6	0.0972	2	Winter	ovx	Autumn	3
32	6	0.0975	4	Winter	ovx	Autumn	3
32	6	0.0978	3	Winter	ovx	Autumn	3
32	6	0.0981	4	Winter	ovx	Autumn	3
32	6	0.0984	2	Winter	ovx	Autumn	3
32	6	0.0988	5	Winter	ovx	Autumn	3
32	6	0.0991	1	Winter	ovx	Autumn	3
32	6	0.0994	1	Winter	ovx	Autumn	3
32	6	0.0997	5	Winter	ovx	Autumn	3
32	6	0.1000	0	Winter	ovx	Autumn	3
32	6	0.1003	1	Winter	ovx	Autumn	3
32	6	0.1006	3	Winter	ovx	Autumn	3
32	6	0.1009	1	Winter	ovx	Autumn	3
32	6	0.1012	0	Winter	ovx	Autumn	3
32	6	0.1015	3	Winter	ovx	Autumn	3
32	6	0.1018	1	Winter	ovx	Autumn	3
32	6	0.1022	2	Winter	ovx	Autumn	3
32	6	0.1025	0	Winter	ovx	Autumn	3
32	6	0.1028	4	Winter	ovx	Autumn	3
32	6	0.1031	5	Winter	ovx	Autumn	3
32	6	0.1034	4	Winter	ovx	Autumn	3
32	6	0.1037	1	Winter	ovx	Autumn	3
32	6	0.1040	1	Winter	ovx	Autumn	3
32	6	0.1043	2	Winter	ovx	Autumn	3
32	6	0.1046	0	Winter	ovx	Autumn	3
32	6	0.1049	2	Winter	ovx	Autumn	3
32	6	0.1052	0	Winter	ovx	Autumn	3
32	6	0.1055	4	Winter	ovx	Autumn	3
32	6	0.1058	1	Winter	ovx	Autumn	3
32	6	0.1061	3	Winter	ovx	Autumn	3
32	6	0.1064	0	Winter	ovx	Autumn	3
32	6	0.1067	2	Winter	ovx	Autumn	3
32	6	0.1070	1	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	6	0.1073	1	Winter	ovx	Autumn	3
32	6	0.1076	2	Winter	ovx	Autumn	3
32	6	0.1079	2	Winter	ovx	Autumn	3
32	6	0.1082	1	Winter	ovx	Autumn	3
32	6	0.1085	1	Winter	ovx	Autumn	3
32	6	0.1088	3	Winter	ovx	Autumn	3
32	6	0.1091	0	Winter	ovx	Autumn	3
32	6	0.1094	0	Winter	ovx	Autumn	3
32	6	0.1097	1	Winter	ovx	Autumn	3
32	6	0.1100	2	Winter	ovx	Autumn	3
32	6	0.1103	2	Winter	ovx	Autumn	3
32	6	0.1106	3	Winter	ovx	Autumn	3
32	6	0.1109	0	Winter	ovx	Autumn	3
32	6	0.1112	2	Winter	ovx	Autumn	3
32	6	0.1115	1	Winter	ovx	Autumn	3
32	6	0.1118	2	Winter	ovx	Autumn	3
32	6	0.1122	2	Winter	ovx	Autumn	3
32	6	0.1125	2	Winter	ovx	Autumn	3
32	6	0.1128	0	Winter	ovx	Autumn	3
32	6	0.1131	0	Winter	ovx	Autumn	3
32	6	0.1134	2	Winter	ovx	Autumn	3
32	6	0.1137	1	Winter	ovx	Autumn	3
32	6	0.1140	0	Winter	ovx	Autumn	3
32	6	0.1143	1	Winter	ovx	Autumn	3
32	6	0.1146	2	Winter	ovx	Autumn	3
32	6	0.1149	0	Winter	ovx	Autumn	3
32	6	0.1152	1	Winter	ovx	Autumn	3
32	6	0.1155	0	Winter	ovx	Autumn	3
32	6	0.1158	1	Winter	ovx	Autumn	3
32	6	0.1161	2	Winter	ovx	Autumn	3
32	6	0.1165	1	Winter	ovx	Autumn	3
32	6	0.1168	0	Winter	ovx	Autumn	3
32	6	0.1171	1	Winter	ovx	Autumn	3
32	6	0.1174	0	Winter	ovx	Autumn	3
32	6	0.1177	2	Winter	ovx	Autumn	3
32	6	0.1180	1	Winter	ovx	Autumn	3
32	6	0.1183	0	Winter	ovx	Autumn	3
32	6	0.1187	2	Winter	ovx	Autumn	3
32	6	0.1190	1	Winter	ovx	Autumn	3
32	6	0.1193	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	6	0.1196	0	Winter	ovx	Autumn	3
32	6	0.1199	1	Winter	ovx	Autumn	3
32	6	0.1203	1	Winter	ovx	Autumn	3
32	6	0.1206	1	Winter	ovx	Autumn	3
32	6	0.1209	1	Winter	ovx	Autumn	3
32	6	0.1212	1	Winter	ovx	Autumn	3
32	6	0.1216	1	Winter	ovx	Autumn	3
32	6	0.1219	0	Winter	ovx	Autumn	3
32	6	0.1222	2	Winter	ovx	Autumn	3
32	6	0.1226	1	Winter	ovx	Autumn	3
32	6	0.1229	0	Winter	ovx	Autumn	3
32	6	0.1232	1	Winter	ovx	Autumn	3
32	6	0.1236	2	Winter	ovx	Autumn	3
32	6	0.1239	0	Winter	ovx	Autumn	3
32	6	0.1243	0	Winter	ovx	Autumn	3
32	6	0.1246	0	Winter	ovx	Autumn	3
32	6	0.1249	1	Winter	ovx	Autumn	3
32	6	0.1253	0	Winter	ovx	Autumn	3
32	6	0.1256	0	Winter	ovx	Autumn	3
32	6	0.1260	0	Winter	ovx	Autumn	3
32	6	0.1263	0	Winter	ovx	Autumn	3
32	6	0.1267	0	Winter	ovx	Autumn	3
32	6	0.1270	0	Winter	ovx	Autumn	3
32	6	0.1274	0	Winter	ovx	Autumn	3
32	6	0.1278	0	Winter	ovx	Autumn	3
32	6	0.1281	0	Winter	ovx	Autumn	3
32	6	0.1285	0	Winter	ovx	Autumn	3
32	6	0.1288	0	Winter	ovx	Autumn	3
32	6	0.1292	0	Winter	ovx	Autumn	3
32	6	0.1296	0	Winter	ovx	Autumn	3
32	6	0.1300	0	Winter	ovx	Autumn	3
32	6	0.1303	0	Winter	ovx	Autumn	3
32	6	0.1307	0	Winter	ovx	Autumn	3
32	6	0.1311	0	Winter	ovx	Autumn	3
32	6	0.1315	0	Winter	ovx	Autumn	3
32	6	0.1319	0	Winter	ovx	Autumn	3
32	6	0.1323	0	Winter	ovx	Autumn	3
32	6	0.1327	0	Winter	ovx	Autumn	3
32	6	0.1331	0	Winter	ovx	Autumn	3
32	6	0.1335	0	Winter	ovx	Autumn	3

Sheep Eartag	Sector	ETA (mm)	Bone Pixels	Sacrifice Season	Treatment	Season of surgery	Time (months)
32	6	0.1339	0	Winter	ovx	Autumn	3
32	6	0.1343	0	Winter	ovx	Autumn	3
32	6	0.1347	0	Winter	ovx	Autumn	3
32	6	0.1351	0	Winter	ovx	Autumn	3
32	6	0.1355	0	Winter	ovx	Autumn	3
32	6	0.1359	0	Winter	ovx	Autumn	3
32	6	0.1364	0	Winter	ovx	Autumn	3
32	6	0.1368	0	Winter	ovx	Autumn	3
32	6	0.1372	0	Winter	ovx	Autumn	3
32	6	0.1377	0	Winter	ovx	Autumn	3
32	6	0.1381	0	Winter	ovx	Autumn	3
32	6	0.1386	0	Winter	ovx	Autumn	3
32	6	0.1390	0	Winter	ovx	Autumn	3
32	6	0.1395	0	Winter	ovx	Autumn	3
32	6	0.1400	0	Winter	ovx	Autumn	3
32	6	0.1404	0	Winter	ovx	Autumn	3
32	6	0.1409	0	Winter	ovx	Autumn	3
32	6	0.1414	0	Winter	ovx	Autumn	3
32	6	0.1419	0	Winter	ovx	Autumn	3
32	6	0.1424	0	Winter	ovx	Autumn	3
32	6	0.1429	0	Winter	ovx	Autumn	3
32	6	0.1434	0	Winter	ovx	Autumn	3
32	6	0.1439	0	Winter	ovx	Autumn	3
32	6	0.1444	0	Winter	ovx	Autumn	3
32	6	0.1450	0	Winter	ovx	Autumn	3
32	6	0.1455	0	Winter	ovx	Autumn	3
32	6	0.1461	0	Winter	ovx	Autumn	3

9. APPENDIX C: SUMMARY OF RAW DATA AVERAGES

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C01	1	1	0.0836	0.0189	control	Summer	12	
C01	1	2	0.1012	0.0132	control	Summer	12	
C01	1	3	0.1042	0.0080	control	Summer	12	
C01	1	4	0.0638	0.0122	control	Summer	12	
C01	1	5	0.0726	0.0138	control	Summer	12	
C01	1	6	0.0893	0.0116	control	Summer	12	
C02	2	1	0.0308	0.0329	ovx	Summer	3	Fall
C02	2	2	0.0493	0.0323	ovx	Summer	3	Fall
C02	2	3	0.0571	0.0285	ovx	Summer	3	Fall
C02	2	4	0.0244	0.0305	ovx	Summer	3	Fall
C02	2	5	0.0002	0.0036	ovx	Summer	3	Fall
C02	2	6	0.0245	0.0306	ovx	Summer	3	Fall
C03	3	1	0.0418	0.0092	control	Summer	12	
C03	3	2	0.0602	0.0094	control	Summer	12	
C03	3	3	0.0523	0.0101	control	Summer	12	
C03	3	4	0.0238	0.0120	control	Summer	12	
C03	3	5	0.0283	0.0127	control	Summer	12	
C03	3	6	0.0427	0.0051	control	Summer	12	
C04	4	1	0.0656		ovx	Summer	12	
C04	4	2	0.0431		ovx	Summer	12	
C04	4	3	0.0445		ovx	Summer	12	
C04	4	4	0.0376		ovx	Summer	12	
C04	4	5	0.0461		ovx	Summer	12	
C04	4	6	0.0648		ovx	Summer	12	
C05	5	1	0.0793		ovx	Summer	12	
C05	5	2	0.0633		ovx	Summer	12	
C05	5	3	0.0817		ovx	Summer	12	
C05	5	4	0.0586		ovx	Summer	12	
C05	5	5	0.0613		ovx	Summer	12	
C05	5	6	0.0546		ovx	Summer	12	
C06	6	1	0.0582	0.0054	control	Summer	12	
C06	6	2	0.0572	0.0062	control	Summer	12	
C06	6	3	0.0613	0.0071	control	Summer	12	
C06	6	4	0.0497	0.0068	control	Summer	12	
C06	6	5	0.0360	0.0052	control	Summer	12	
C06	6	6	0.0471	0.0081	control	Summer	12	

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C07	7	1	0.0355	0.0085	control	Summer	12	
C07	7	2	0.0338	0.0052	control	Summer	12	
C07	7	3	0.0453	0.0067	control	Summer	12	
C07	7	4	0.0365	0.0072	control	Summer	12	
C07	7	5	0.0420	0.0065	control	Summer	12	
C07	7	6	0.0320	0.0060	control	Summer	12	
C08	8	1	0.0440		ovx	Summer	12	
C08	8	2	0.0407		ovx	Summer	12	
C08	8	3	0.0258		ovx	Summer	12	
C08	8	4	0.0390		ovx	Summer	12	
C08	8	5	0.0266		ovx	Summer	12	
C08	8	6	0.0346		ovx	Summer	12	
C09	9	1	0.0631	0.0253	ovx	Summer	3	Fall
C09	9	2	0.0784	0.0152	ovx	Summer	3	Fall
C09	9	3	0.0075	0.0194	ovx	Summer	3	Fall
C09	9	4	0.0452	0.0323	ovx	Summer	3	Fall
C09	9	5	0.0687	0.0241	ovx	Summer	3	Fall
C09	9	6	0.0004	0.0044	ovx	Summer	3	Fall
C11	11	1	0.0533	0.0057	control	Summer	12	
C11	11	2	0.0463	0.0069	control	Summer	12	
C11	11	3	0.0542	0.0062	control	Summer	12	
C11	11	4	0.0609	0.0055	control	Summer	12	
C11	11	5	0.0478	0.0074	control	Summer	12	
C11	11	6	0.0351	0.0087	control	Summer	12	
C12	12	1	0.0586	0.0035	ovx	Summer	3	Fall
C12	12	2	0.0336	0.0058	ovx	Summer	3	Fall
C12	12	3	0.0512	0.0053	ovx	Summer	3	Fall
C12	12	4	0.0464	0.0043	ovx	Summer	3	Fall
C12	12	5	0.0470	0.0055	ovx	Summer	3	Fall
C12	12	6	0.0515	0.0048	ovx	Summer	3	Fall
C13	13	1	0.0481		ovx	Summer	12	
C13	13	2	0.0646		ovx	Summer	12	
C13	13	3	0.0765		ovx	Summer	12	
C13	13	4	0.0632		ovx	Summer	12	
C13	13	6	0.0494		ovx	Summer	12	
C14	14	1	0.0000	0.0000	ovx	Summer	3	Fall
C14	14	2	0.0000	0.0000	ovx	Summer	3	Fall
C14	14	3	0.0000	0.0000	ovx	Summer	3	Fall
C14	14	4	0.0000	0.0000	ovx	Summer	3	Fall

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C14	14	5	0.0000	0.0000	ovx	Summer	3	Fall
C14	14	6	0.0000	0.0000	ovx	Summer	3	Fall
C15	15	1	0.0727	0.0070	control	Summer	3	Fall
C15	15	2	0.0696	0.0048	control	Summer	3	Fall
C15	15	3	0.0695	0.0051	control	Summer	3	Fall
C15	15	4	0.0753	0.0062	control	Summer	3	Fall
C15	15	5	0.0736	0.0062	control	Summer	3	Fall
C15	15	6	0.0760	0.0053	control	Summer	3	Fall
C16	16	1	0.0582	0.0062	control	Summer	3	Fall
C16	16	2	0.0484	0.0100	control	Summer	3	Fall
C16	16	3	0.0572	0.0053	control	Summer	3	Fall
C16	16	4	0.0513	0.0069	control	Summer	3	Fall
C16	16	5	0.0382	0.0156	control	Summer	3	Fall
C16	16	6	0.0638	0.0067	control	Summer	3	Fall
C17	17	1	0.0618	0.0161	control	Summer	3	Fall
C17	17	2	0.0618	0.0137	control	Summer	3	Fall
C17	17	3	0.0632	0.0090	control	Summer	3	Fall
C17	17	4	0.0621	0.0122	control	Summer	3	Fall
C17	17	5	0.0506	0.0221	control	Summer	3	Fall
C17	17	6	0.0704	0.0067	control	Summer	3	Fall
C18	18	1	0.0776		ovx	Summer	12	
C18	18	2	0.0710		ovx	Summer	12	
C18	18	3	0.0684		ovx	Summer	12	
C18	18	4	0.0665		ovx	Summer	12	
C18	18	5	0.0608		ovx	Summer	12	
C18	18	6	0.0740		ovx	Summer	12	
C19	19	1	0.0431	0.0049	ovx	Summer	3	Fall
C19	19	2	0.0502	0.0042	ovx	Summer	3	Fall
C19	19	3	0.0529	0.0051	ovx	Summer	3	Fall
C19	19	4	0.0578	0.0052	ovx	Summer	3	Fall
C19	19	5	0.0621	0.0044	ovx	Summer	3	Fall
C19	19	6	0.0496	0.0083	ovx	Summer	3	Fall
C20	20	1	0.0400	0.0329	ovx	Summer	3	Fall
C20	20	2	0.0402	0.0339	ovx	Summer	3	Fall
C20	20	3	0.0151	0.0259	ovx	Summer	3	Fall
C20	20	4	0.0151	0.0265	ovx	Summer	3	Fall
C20	20	5	0.0109	0.0231	ovx	Summer	3	Fall
C20	20	6	0.0125	0.0241	ovx	Summer	3	Fall
C21	21	2	0.0534	0.0051	ovx	Summer	3	Fall

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C22	22	1	0.0469	0.0098	control	Summer	12	
C22	22	2	0.0569	0.0058	control	Summer	12	
C22	22	3	0.0495	0.0073	control	Summer	12	
C22	22	4	0.0548	0.0079	control	Summer	12	
C22	22	5	0.0604	0.0079	control	Summer	12	
C22	22	6	0.0379	0.0055	control	Summer	12	
C23	23	1	0.0613	0.0052	control	Summer	3	Fall
C23	23	2	0.0587	0.0040	control	Summer	3	Fall
C23	23	3	0.0695	0.0051	control	Summer	3	Fall
C23	23	4	0.0580	0.0057	control	Summer	3	Fall
C23	23	5	0.0683	0.0034	control	Summer	3	Fall
C23	23	6	0.0587	0.0066	control	Summer	3	Fall
C24	24	1	0.0610	0.0086	control	Summer	3	Fall
C24	24	2	0.0333	0.0129	control	Summer	3	Fall
C24	24	3	0.0374	0.0170	control	Summer	3	Fall
C24	24	4	0.0652	0.0067	control	Summer	3	Fall
C24	24	5	0.0426	0.0217	control	Summer	3	Fall
C24	24	6	0.0389	0.0175	control	Summer	3	Fall
C25	25	1	0.0591	0.0271	ovx	Summer	3	Fall
C25	25	2	0.0010	0.0074	ovx	Summer	3	Fall
C25	25	3	0.0521	0.0297	ovx	Summer	3	Fall
C25	25	4	0.0008	0.0066	ovx	Summer	3	Fall
C25	25	5	0.0421	0.0321	ovx	Summer	3	Fall
C25	25	6	0.0004	0.0045	ovx	Summer	3	Fall
C26	26	1	0.0285	0.0052	control	Summer	12	
C26	26	2	0.0137	0.0049	control	Summer	12	
C26	26	3	0.0253	0.0044	control	Summer	12	
C26	26	4	0.0146	0.0047	control	Summer	12	
C26	26	5	0.0151	0.0046	control	Summer	12	
C26	26	6	0.0203	0.0063	control	Summer	12	
C27	27	1	0.0643	0.0040	control	Summer	3	Fall
C27	27	2	0.0538	0.0053	control	Summer	3	Fall
C27	27	3	0.0620	0.0053	control	Summer	3	Fall
C27	27	4	0.0597	0.0039	control	Summer	3	Fall
C27	27	5	0.0482	0.0058	control	Summer	3	Fall
C27	27	6	0.0518	0.0075	control	Summer	3	Fall
C28	28	1	0.0504	0.0052	control	Summer	3	Fall
C28	28	2	0.0497	0.0052	control	Summer	3	Fall

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C28	28	3	0.0314	0.0059	control	Summer	3	Fall
C28	28	4	0.0236	0.0073	control	Summer	3	Fall
C28	28	5	0.0346	0.0046	control	Summer	3	Fall
C28	28	6	0.0664	0.0043	control	Summer	3	Fall
C29	29	1	0.0938		control	Summer	12	Fall
C29	29	2	0.0862		control	Summer	12	Fall
C29	29	4	0.0828		control	Summer	12	Fall
C29	29	5	0.0720		control	Summer	12	Fall
C29	29	6	0.0889		control	Summer	12	Fall
C30	30	1	0.0584		ovx	Fall	12	
C30	30	2	0.0543		ovx	Fall	12	
C30	30	4	0.0653		ovx	Fall	12	
C30	30	5	0.0598		ovx	Fall	12	
C31	31	1	0.0353	0.0042	ovx	Autumn	3	Winter
C31	31	2	0.0358	0.0038	ovx	Autumn	3	Winter
C31	31	3	0.0369	0.0045	ovx	Autumn	3	Winter
C31	31	4	0.0338	0.0053	ovx	Autumn	3	Winter
C31	31	5	0.0325	0.0048	ovx	Autumn	3	Winter
C31	31	6	0.0400	0.0048	ovx	Autumn	3	Winter
C32	32	1	0.0757	0.0069	ovx	Autumn	3	Winter
C32	32	2	0.0729	0.0067	ovx	Autumn	3	Winter
C32	32	3	0.0627	0.0168	ovx	Autumn	3	Winter
C32	32	4	0.0788	0.0072	ovx	Autumn	3	Winter
C32	32	5	0.0715	0.0078	ovx	Autumn	3	Winter
C32	32	6	0.0725	0.0067	ovx	Autumn	3	Winter
C33	33	1	0.0712		ovx	Fall	12	
C33	33	2	0.0681		ovx	Fall	12	
C33	33	3	0.0592		ovx	Fall	12	
C33	33	4	0.0774		ovx	Fall	12	
C33	33	5	0.0637		ovx	Fall	12	
C33	33	6	0.0689		ovx	Fall	12	
C34	34	1	0.0783	0.0105	ovx	Autumn	3	Winter
C34	34	2	0.0557	0.0109	ovx	Autumn	3	Winter
C34	34	3	0.0868	0.0063	ovx	Autumn	3	Winter
C34	34	4	0.0750	0.0083	ovx	Autumn	3	Winter
C34	34	5	0.0827	0.0054	ovx	Autumn	3	Winter
C34	34	6	0.0702	0.0047	ovx	Autumn	3	Winter
C35	35	1	0.0835	0.0055	ovx	Autumn	3	Winter
C35	35	2	0.0683	0.0091	ovx	Autumn	3	Winter

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C35	35	3	0.0840	0.0043	ovx	Autumn	3	Winter
C35	35	4	0.0710	0.0053	ovx	Autumn	3	Winter
C35	35	5	0.0697	0.0086	ovx	Autumn	3	Winter
C35	35	6	0.0738	0.0145	ovx	Autumn	3	Winter
C36	36	1	0.0546	0.0076	ovx	Autumn	3	Winter
C36	36	2	0.0430	0.0098	ovx	Autumn	3	Winter
C36	36	3	0.0554	0.0098	ovx	Autumn	3	Winter
C36	36	4	0.0498	0.0079	ovx	Autumn	3	Winter
C36	36	5	0.0558	0.0070	ovx	Autumn	3	Winter
C36	36	6	0.0510	0.0224	ovx	Autumn	3	Winter
C37	37	1	0.0498	0.0116	ovx	Autumn	3	Winter
C37	37	2	0.0648	0.0058	ovx	Autumn	3	Winter
C37	37	3	0.0629	0.0063	ovx	Autumn	3	Winter
C37	37	4	0.0563	0.0063	ovx	Autumn	3	Winter
C37	37	5	0.0552	0.0069	ovx	Autumn	3	Winter
C37	37	6	0.0530	0.0054	ovx	Autumn	3	Winter
C38	38	1	0.0699	0.0080	ovx	Autumn	3	Winter
C38	38	2	0.0625	0.0145	ovx	Autumn	3	Winter
C38	38	3	0.0638	0.0073	ovx	Autumn	3	Winter
C38	38	4	0.0649	0.0088	ovx	Autumn	3	Winter
C38	38	5	0.0577	0.0122	ovx	Autumn	3	Winter
C38	38	6	0.0773	0.0092	ovx	Autumn	3	Winter
C39	39	1	0.0585		ovx	Fall	12	
C39	39	2	0.0570		ovx	Fall	12	
C39	39	3	0.0526		ovx	Fall	12	
C39	39	4	0.0427		ovx	Fall	12	
C39	39	5	0.0490		ovx	Fall	12	
C39	39	6	0.0560		ovx	Fall	12	
C40	40	1	0.0721		ovx	Fall	12	
C40	40	2	0.0728		ovx	Fall	12	
C40	40	3	0.0773		ovx	Fall	12	
C40	40	4	0.0570		ovx	Fall	12	
C40	40	5	0.0765		ovx	Fall	12	
C40	40	6	0.0788		ovx	Fall	12	
C42	42	1	0.0372		ovx	Fall	12	
C42	42	2	0.0637		ovx	Fall	12	
C42	42	3	0.0685		ovx	Fall	12	
C42	42	4	0.0597		ovx	Fall	12	
C42	42	5	0.0550		ovx	Fall	12	

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C42	42	6	0.0666		ovx	Fall	12	
C43	43	1	0.0705	0.0072	control	Autumn	3	Winter
C43	43	2	0.0508	0.0069	control	Autumn	3	Winter
C43	43	3	0.0601	0.0059	control	Autumn	3	Winter
C43	43	4	0.0525	0.0075	control	Autumn	3	Winter
C43	43	5	0.0543	0.0046	control	Autumn	3	Winter
C43	43	6	0.0466	0.0055	control	Autumn	3	Winter
C44	44	1	0.0559	0.0079	control	Fall	12	
C44	44	2	0.0607	0.0087	control	Fall	12	
C44	44	3	0.0524	0.0118	control	Fall	12	
C44	44	4	0.0432	0.0110	control	Fall	12	
C44	44	5	0.0500	0.0087	control	Fall	12	
C44	44	6	0.0337	0.0092	control	Fall	12	
C45	45	1	0.0903	0.0075	control	Autumn	3	Winter
C45	45	2	0.0822	0.0064	control	Autumn	3	Winter
C45	45	3	0.0778	0.0083	control	Autumn	3	Winter
C45	45	4	0.0906	0.0044	control	Autumn	3	Winter
C45	45	5	0.0811	0.0048	control	Autumn	3	Winter
C45	45	6	0.0736	0.0094	control	Autumn	3	Winter
C46	46	1	0.0574	0.0150	control	Fall	12	
C46	46	2	0.0535	0.0125	control	Fall	12	
C46	46	3	0.0754	0.0104	control	Fall	12	
C46	46	4	0.0690	0.0082	control	Fall	12	
C46	46	5	0.0632	0.0110	control	Fall	12	
C46	46	6	0.0642	0.0091	control	Fall	12	
C47	47	1	0.0576	0.0099	control	Fall	12	
C47	47	2	0.0586	0.0081	control	Fall	12	
C47	47	3	0.0426	0.0102	control	Fall	12	
C47	47	4	0.0591	0.0044	control	Fall	12	
C47	47	5	0.0559	0.0082	control	Fall	12	
C47	47	6	0.0480	0.0074	control	Fall	12	
C49	49	1	0.0750	0.0084	control	Autumn	3	Winter
C49	49	2	0.0431	0.0050	control	Autumn	3	Winter
C49	49	3	0.0714	0.0080	control	Autumn	3	Winter
C49	49	4	0.0784	0.0089	control	Autumn	3	Winter
C49	49	5	0.0664	0.0055	control	Autumn	3	Winter
C49	49	6	0.0773	0.0079	control	Autumn	3	Winter
C50	50	1	0.0695	0.0099	control	Fall	12	
C50	50	2	0.0728	0.0088	control	Fall	12	

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C50	50	3	0.0672	0.0098	control	Fall	12	
C50	50	4	0.0682	0.0110	control	Fall	12	
C50	50	6	0.0731	0.0076	control	Fall	12	
C51	51	1	0.0806	0.0185	control	Autumn	3	Winter
C51	51	2	0.0741	0.0152	control	Autumn	3	Winter
C51	51	3	0.0563	0.0187	control	Autumn	3	Winter
C51	51	4	0.0723	0.0110	control	Autumn	3	Winter
C51	51	5	0.0738	0.0165	control	Autumn	3	Winter
C51	51	6	0.0894	0.0117	control	Autumn	3	Winter
C52	52	1	0.1209	0.0105	control	Autumn	3	Winter
C52	52	2	0.1210	0.0106	control	Autumn	3	Winter
C52	52	3	0.1145	0.0162	control	Autumn	3	Winter
C52	52	4	0.1019	0.0115	control	Autumn	3	Winter
C52	52	5	0.0973	0.0107	control	Autumn	3	Winter
C52	52	6	0.1312	0.0079	control	Autumn	3	Winter
C53	53	1	0.1438	0.0159	control	Autumn	3	Winter
C53	53	2	0.1337	0.0085	control	Autumn	3	Winter
C53	53	3	0.1451	0.0084	control	Autumn	3	Winter
C53	53	4	0.1192	0.0123	control	Autumn	3	Winter
C53	53	5	0.0937	0.0256	control	Autumn	3	Winter
C53	53	6	0.1088	0.0103	control	Autumn	3	Winter
C54	54	1	1.1629	0.0065	control	Fall	12	
C54	54	2	1.2382	0.0072	control	Fall	12	
C54	54	3	1.2036	0.0087	control	Fall	12	
C54	54	4	1.1804	0.0091	control	Fall	12	
C54	54	5	1.1876	0.0118	control	Fall	12	
C54	54	6	1.1807	0.0082	control	Fall	12	
C55	55	1	0.0332	0.0076	control	Fall	12	
C55	55	2	0.0431	0.0093	control	Fall	12	
C55	55	3	0.0429	0.0111	control	Fall	12	
C55	55	4	0.0469	0.0076	control	Fall	12	
C55	55	5	0.0251	0.0065	control	Fall	12	
C55	55	6	0.0326	0.0069	control	Fall	12	
C56	56	1	0.1177	0.0053	control	Autumn	3	Winter
C56	56	2	0.1120	0.0074	control	Autumn	3	Winter
C56	56	3	0.1250	0.0091	control	Autumn	3	Winter
C56	56	4	0.1078	0.0164	control	Autumn	3	Winter
C56	56	5	0.1203	0.0070	control	Autumn	3	Winter
C56	56	6	0.1201	0.0065	control	Autumn	3	Winter

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C58	58	1	0.0662		ovx	Winter	12	
C58	58	2	0.0727		ovx	Winter	12	
C58	58	3	0.0736		ovx	Winter	12	
C58	58	4	0.0724		ovx	Winter	12	
C58	58	6	0.0751		ovx	Winter	12	
C59	59	1	0.0657	0.0066	control	Winter	12	
C59	59	2	0.0552	0.0048	control	Winter	12	
C59	59	3	0.0716	0.0077	control	Winter	12	
C59	59	4	0.0636	0.0084	control	Winter	12	
C59	59	5	0.0577	0.0052	control	Winter	12	
C59	59	6	0.0575	0.0064	control	Winter	12	
C60	60	1	0.0469	0.0054	ovx	Winter	3	Spring
C60	60	2	0.0508	0.0034	ovx	Winter	3	Spring
C60	60	3	0.0481	0.0090	ovx	Winter	3	Spring
C60	60	4	0.0540	0.0047	ovx	Winter	3	Spring
C60	60	5	0.0537	0.0038	ovx	Winter	3	Spring
C60	60	6	0.0498	0.0058	ovx	Winter	3	Spring
C61	61	1	0.0746	0.0031	ovx	Winter	3	Spring
C61	61	2	0.0760	0.0027	ovx	Winter	3	Spring
C61	61	3	0.0715	0.0036	ovx	Winter	3	Spring
C61	61	4	0.0705	0.0032	ovx	Winter	3	Spring
C61	61	5	0.0705	0.0024	ovx	Winter	3	Spring
C61	61	6	0.0726	0.0027	ovx	Winter	3	Spring
C62	62	1	0.0650		ovx	Winter	12	
C62	62	2	0.0649		ovx	Winter	12	
C62	62	3	0.0754		ovx	Winter	12	
C62	62	4	0.0703		ovx	Winter	12	
C62	62	5	0.0646		ovx	Winter	12	
C62	62	6	0.0692		ovx	Winter	12	
C63	63	1	0.0636	0.0001	control	Winter	3	Spring
C63	63	2	0.0635	0.0001	control	Winter	3	Spring
C63	63	3	0.0634	0.0001	control	Winter	3	Spring
C63	63	4	0.0635	0.0001	control	Winter	3	Spring
C63	63	5	0.0637	0.0001	control	Winter	3	Spring
C63	63	6	0.0638	0.0001	control	Winter	3	Spring
C65	65	1	0.0395	0.0045	ovx	Winter	3	Spring
C65	65	2	0.0738	0.0052	ovx	Winter	3	Spring
C65	65	3	0.0735	0.0054	ovx	Winter	3	Spring
C65	65	4	0.0825	0.0074	ovx	Winter	3	Spring

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C65	65	5	0.0859	0.0060	ovx	Winter	3	Spring
C65	65	6	0.0829	0.0090	ovx	Winter	3	Spring
C66	66	1	0.0120	0.0052	control	Winter	3	Spring
C66	66	2	0.0149	0.0047	control	Winter	3	Spring
C66	66	3	0.0131	0.0071	control	Winter	3	Spring
C66	66	4	0.0164	0.0057	control	Winter	3	Spring
C66	66	5	0.0037	0.0047	control	Winter	3	Spring
C66	66	6	0.0163	0.0055	control	Winter	3	Spring
C67	67	1	0.0768		ovx	Winter	12	
C67	67	2	0.0644		ovx	Winter	12	
C67	67	3	0.0677		ovx	Winter	12	
C67	67	4	0.0814		ovx	Winter	12	
C67	67	5	0.0709		ovx	Winter	12	
C67	67	6	0.0741		ovx	Winter	12	
C68	68	1	0.0745		ovx	Winter	12	
C68	68	2	0.0663		ovx	Winter	12	
C68	68	3	0.0742		ovx	Winter	12	
C68	68	4	0.0584		ovx	Winter	12	
C68	68	5	0.0564		ovx	Winter	12	
C68	68	6	0.0725		ovx	Winter	12	
C69	69	1	0.0557	0.0075	ovx	Winter	3	Spring
C69	69	2	0.0439	0.0095	ovx	Winter	3	Spring
C69	69	3	0.0291	0.0146	ovx	Winter	3	Spring
C69	69	4	0.0533	0.0072	ovx	Winter	3	Spring
C69	69	5	0.0517	0.0087	ovx	Winter	3	Spring
C69	69	6	0.0567	0.0086	ovx	Winter	3	Spring
C70	70	1	0.0486		ovx	Winter	12	
C70	70	2	0.0324		ovx	Winter	12	
C70	70	3	0.0389		ovx	Winter	12	
C70	70	5	0.0315		ovx	Winter	12	
C70	70	6	0.0448		ovx	Winter	12	
C71	71	1	0.0521		ovx	Winter	12	
C71	71	2	0.0436		ovx	Winter	12	
C71	71	3	0.0475		ovx	Winter	12	
C71	71	4	0.0503		ovx	Winter	12	
C71	71	5	0.0430		ovx	Winter	12	
C71	71	6	0.0414		ovx	Winter	12	
C72	72	1	0.0379	0.0112	control	Winter	3	Spring
C72	72	2	0.0611	0.0064	control	Winter	3	Spring

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C72	72	3	0.0717	0.0069	control	Winter	3	Spring
C72	72	4	0.0646	0.0086	control	Winter	3	Spring
C72	72	5	0.0328	0.0135	control	Winter	3	Spring
C72	72	6	0.0771	0.0047	control	Winter	3	Spring
C73	73	1	0.0789	0.0048	control	Winter	3	Spring
C73	73	2	0.0738	0.0059	control	Winter	3	Spring
C73	73	3	0.0645	0.0106	control	Winter	3	Spring
C73	73	4	0.0819	0.0044	control	Winter	3	Spring
C73	73	5	0.0621	0.0064	control	Winter	3	Spring
C73	73	6	0.0632	0.0080	control	Winter	3	Spring
C74	74	1	0.0373	0.0098	ovx	Winter	3	Spring
C74	74	2	0.0481	0.0048	ovx	Winter	3	Spring
C74	74	3	0.0637	0.0094	ovx	Winter	3	Spring
C74	74	4	0.0498	0.0049	ovx	Winter	3	Spring
C74	74	5	0.0491	0.0051	ovx	Winter	3	Spring
C74	74	6	0.0385	0.0074	ovx	Winter	3	Spring
C75	75	1	0.0249	0.0084	control	Winter	12	
C75	75	2	0.0330	0.0042	control	Winter	12	
C75	75	3	0.0267	0.0055	control	Winter	12	
C75	75	4	0.0343	0.0048	control	Winter	12	
C75	75	5	0.0277	0.0041	control	Winter	12	
C75	75	6	0.0390	0.0050	control	Winter	12	
C76	76	1	0.0371	0.0020	ovx	Winter	3	Spring
C76	76	2	0.0354	0.0034	ovx	Winter	3	Spring
C76	76	3	0.0357	0.0028	ovx	Winter	3	Spring
C76	76	4	0.0360	0.0024	ovx	Winter	3	Spring
C76	76	5	0.0343	0.0021	ovx	Winter	3	Spring
C76	76	6	0.0309	0.0026	ovx	Winter	3	Spring
C77	77	1	0.0428	0.0051	control	Winter	12	
C77	77	2	0.0374	0.0045	control	Winter	12	
C77	77	3	0.0403	0.0070	control	Winter	12	
C77	77	4	0.0352	0.0052	control	Winter	12	
C77	77	5	0.0361	0.0050	control	Winter	12	
C77	77	6	0.0288	0.0049	control	Winter	12	
C78	78	1	0.0797	0.0055	ovx	Winter	3	Spring
C78	78	2	0.0803	0.0061	ovx	Winter	3	Spring
C78	78	3	0.0802	0.0046	ovx	Winter	3	Spring
C78	78	4	0.0817	0.0056	ovx	Winter	3	Spring
C78	78	5	0.0712	0.0067	ovx	Winter	3	Spring

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C78	78	6	0.0787	0.0054	ovx	Winter	3	Spring
C79	79	1	0.0257	0.0052	control	Winter	3	Spring
C79	79	2	0.0213	0.0085	control	Winter	3	Spring
C79	79	3	0.0194	0.0043	control	Winter	3	Spring
C79	79	4	0.0272	0.0034	control	Winter	3	Spring
C79	79	5	0.0761	0.0047	control	Winter	3	Spring
C79	79	6	0.0768	0.0082	control	Winter	3	Spring
C80	80	1	0.0629	0.0079	control	Winter	12	
C80	80	2	0.0396	0.0043	control	Winter	12	
C81	81	1	0.0580	0.0119	control	Winter	3	Spring
C81	81	2	0.0663	0.0080	control	Winter	3	Spring
C81	81	3	0.0646	0.0078	control	Winter	3	Spring
C81	81	4	0.0637	0.0081	control	Winter	3	Spring
C81	81	5	0.0632	0.0144	control	Winter	3	Spring
C81	81	6	0.0722	0.0103	control	Winter	3	Spring
C82	82	1	0.1036	0.0089	control	Winter	12	
C82	82	2	0.0478	0.0048	control	Winter	12	
C82	82	3	0.0591	0.0085	control	Winter	12	
C82	82	4	0.0295	0.0125	control	Winter	12	
C82	82	5	0.0516	0.0076	control	Winter	12	
C82	82	6	0.0487	0.0068	control	Winter	12	
C83	83	1	0.0342	0.0042	control	Winter	12	
C83	83	2	0.0431	0.0033	control	Winter	12	
C83	83	3	0.0394	0.0041	control	Winter	12	
C83	83	4	0.0299	0.0038	control	Winter	12	
C83	83	5	0.0367	0.0055	control	Winter	12	
C83	83	6	0.0299	0.0038	control	Winter	12	
C84	84	1	0.0629	0.0079	control	Winter	12	
C84	84	2	0.0495	0.0059	control	Winter	12	
C84	84	3	0.0483	0.0060	control	Winter	12	
C84	84	4	0.0614	0.0087	control	Winter	12	
C84	84	5	0.0513	0.0089	control	Winter	12	
C84	84	6	0.0365	0.0217	control	Winter	12	
C85	85	1	0.0799	0.0062	ovx	Spring	3	Summer
C85	85	2	0.0607	0.0074	ovx	Spring	3	Summer
C85	85	3	0.0710	0.0078	ovx	Spring	3	Summer
C85	85	4	0.0531	0.0076	ovx	Spring	3	Summer
C85	85	5	0.0402	0.0080	ovx	Spring	3	Summer
C85	85	6	0.0577	0.0095	ovx	Spring	3	Summer

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C86	86	1	0.0923	0.0048	control	Spring	3	Summer
C86	86	2	0.0884	0.0061	control	Spring	3	Summer
C86	86	3	0.0882	0.0064	control	Spring	3	Summer
C86	86	4	0.0924	0.0069	control	Spring	3	Summer
C86	86	5	0.0792	0.0066	control	Spring	3	Summer
C86	86	6	0.0999	0.0051	control	Spring	3	Summer
C87	87	1	0.0655	0.0063	ovx	Spring	3	Summer
C87	87	2	0.0534	0.0080	ovx	Spring	3	Summer
C87	87	3	0.0603	0.0067	ovx	Spring	3	Summer
C87	87	4	0.0564	0.0064	ovx	Spring	3	Summer
C87	87	5	0.0506	0.0070	ovx	Spring	3	Summer
C87	87	6	0.0575	0.0078	ovx	Spring	3	Summer
C88	88	1	0.0728	0.0062	control	Spring	3	Summer
C88	88	2	0.0732	0.0052	control	Spring	3	Summer
C88	88	3	0.0845	0.0046	control	Spring	3	Summer
C88	88	4	0.0765	0.0049	control	Spring	3	Summer
C88	88	5	0.0749	0.0055	control	Spring	3	Summer
C88	88	6	0.0773	0.0063	control	Spring	3	Summer
C89	89	1	0.0652		ovx	Spring	12	
C89	89	2	0.0499		ovx	Spring	12	
C89	89	3	0.0637		ovx	Spring	12	
C89	89	4	0.0574		ovx	Spring	12	
C89	89	5	0.0712		ovx	Spring	12	
C89	89	6	0.0505		ovx	Spring	12	
C90	90	1	0.0787	0.0023	ovx	Spring	3	Summer
C90	90	2	0.0675	0.0055	ovx	Spring	3	Summer
C90	90	3	0.0641	0.0058	ovx	Spring	3	Summer
C90	90	4	0.0721	0.0064	ovx	Spring	3	Summer
C90	90	5	0.0674	0.0051	ovx	Spring	3	Summer
C90	90	6	0.0645	0.0054	ovx	Spring	3	Summer
C92	92	1	0.0880	0.0067	control	Spring	3	Summer
C92	92	2	0.0883	0.0056	control	Spring	3	Summer
C92	92	3	0.0741	0.0159	control	Spring	3	Summer
C92	92	4	0.0731	0.0062	control	Spring	3	Summer
C92	92	5	0.0731	0.0062	control	Spring	3	Summer
C92	92	5	0.0624	0.0108	control	Spring	3	Summer
C92	92	6	0.0708	0.0077	control	Spring	3	Summer
C93	93	1	0.0783	0.0039	ovx	Spring	3	Summer
C93	93	2	0.0868	0.0068	ovx	Spring	3	Summer

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C93	93	3	0.0849	0.0060	ovx	Spring	3	Summer
C93	93	4	0.0754	0.0059	ovx	Spring	3	Summer
C93	93	5	0.0601	0.0069	ovx	Spring	3	Summer
C93	93	6	0.0736	0.0074	ovx	Spring	3	Summer
C94	94	1	0.0874	0.0063	control	Spring	3	Summer
C94	94	2	0.0738	0.0061	control	Spring	3	Summer
C94	94	3	0.0826	0.0068	control	Spring	3	Summer
C94	94	4	0.0866	0.0071	control	Spring	3	Summer
C94	94	5	0.0845	0.0079	control	Spring	3	Summer
C94	94	6	0.0985	0.0067	control	Spring	3	Summer
C95	95	1	0.0778	0.0041	control	Spring	3	Summer
C95	95	2	0.0683	0.0055	control	Spring	3	Summer
C95	95	3	0.0667	0.0059	control	Spring	3	Summer
C95	95	4	0.0720	0.0044	control	Spring	3	Summer
C95	95	5	0.0693	0.0054	control	Spring	3	Summer
C95	95	6	0.0636	0.0062	control	Spring	3	Summer
C96	96	1	0.0517	0.0072	control	Spring	12	
C96	96	2	0.0580	0.0051	control	Spring	12	
C96	96	3	0.0572	0.0069	control	Spring	12	
C96	96	4	0.0578	0.0043	control	Spring	12	
C96	96	5	0.0387	0.0067	control	Spring	12	
C96	96	6	0.0496	0.0035	control	Spring	12	
C97	97	1	0.0744	0.0076	control	Spring	12	
C97	97	2	0.0637	0.0083	control	Spring	12	
C97	97	3	0.0602	0.0106	control	Spring	12	
C97	97	4	0.0577	0.0086	control	Spring	12	
C97	97	5	0.0554	0.0078	control	Spring	12	
C97	97	6	0.0545	0.0078	control	Spring	12	
C98	98	1	0.0656		ovx	Spring	12	
C98	98	2	0.0407		ovx	Spring	12	
C98	98	4	0.0555		ovx	Spring	12	
C98	98	5	0.0415		ovx	Spring	12	
C98	98	6	0.0511		ovx	Spring	12	
C99	99	1	0.0324	0.0074	control	Spring	12	
C99	99	2	0.0293	0.0065	control	Spring	12	
C99	99	3	0.0458	0.0106	control	Spring	12	
C99	99	4	0.0513	0.0092	control	Spring	12	
C99	99	5	0.0406	0.0080	control	Spring	12	
C99	99	6	0.0538	0.0082	control	Spring	12	

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C100	100	1	0.0646	0.0138	control	Spring	3	Summer
C100	100	3	0.0748	0.0105	control	Spring	3	Summer
C100	100	4	0.0767	0.0084	control	Spring	3	Summer
C100	100	5	0.0741	0.0056	control	Spring	3	Summer
C100	100	5	0.0519	0.0086	control	Spring	3	Summer
C100	100	6	0.0807	0.0056	control	Spring	3	Summer
C101	101	1	0.0682		ovx	Spring	12	
C101	101	2	0.0639		ovx	Spring	12	
C101	101	3	0.0644		ovx	Spring	12	
C101	101	4	0.0781		ovx	Spring	12	
C101	101	5	0.0577		ovx	Spring	12	
C101	101	6	0.0582		ovx	Spring	12	
C102	102	1	0.0585		ovx	Spring	12	
C102	102	2	0.0600		ovx	Spring	12	
C102	102	3	0.0798		ovx	Spring	12	
C102	102	4	0.0677		ovx	Spring	12	
C102	102	5	0.0663		ovx	Spring	12	
C102	102	6	0.0725		ovx	Spring	12	
C103	103	1	0.0448	0.0098	control	Spring	12	
C103	103	2	0.0415	0.0092	control	Spring	12	
C103	103	3	0.0514	0.0054	control	Spring	12	
C103	103	4	0.0491	0.0057	control	Spring	12	
C103	103	5	0.0152	0.0066	control	Spring	12	
C103	103	6	0.0515	0.0066	control	Spring	12	
C104	104	1	0.0640		ovx	Spring	12	
C104	104	2	0.0665		ovx	Spring	12	
C104	104	3	0.0765		ovx	Spring	12	
C104	104	4	0.0865		ovx	Spring	12	
C104	104	5	0.0679		ovx	Spring	12	
C104	104	6	0.0738		ovx	Spring	12	
C105	105	1	0.0648	0.0083	ovx	Spring	3	Summer
C105	105	2	0.0609	0.0059	ovx	Spring	3	Summer
C105	105	3	0.0586	0.0070	ovx	Spring	3	Summer
C105	105	4	0.0490	0.0122	ovx	Spring	3	Summer
C105	105	5	0.0519	0.0086	ovx	Spring	3	Summer
C105	105	6	0.0588	0.0053	ovx	Spring	3	Summer
C106	106	1	0.1018	0.0056	control	Spring	3	Summer
C106	106	2	0.1055	0.0061	control	Spring	3	Summer
C106	106	3	0.1007	0.0045	control	Spring	3	Summer

Sheep Ear Tag	Plate	Specimen	Mean ETA	SD ETA	Treatment	Season of surgery	Time (months)	Season of Sacrifice
C106	106	4	0.1029	0.0092	control	Spring	3	Summer
C106	106	5	0.0985	0.0067	control	Spring	3	Summer
C106	106	6	0.0889	0.0075	control	Spring	3	Summer
C107	107	1	0.0847	0.0129	ovx	Spring	3	Summer
C107	107	2	0.0708	0.0084	ovx	Spring	3	Summer
C107	107	3	0.0605	0.0100	ovx	Spring	3	Summer
C107	107	4	0.0663	0.0079	ovx	Spring	3	Summer
C107	107	5	0.0601	0.0069	ovx	Spring	3	Summer
C107	107	6	0.0553	0.0093	ovx	Spring	3	Summer
C108	108	1	0.0505	0.0032	control	Spring	12	
C108	108	2	0.0664	0.0033	control	Spring	12	
C108	108	3	0.0437	0.0120	control	Spring	12	
C108	108	4	0.0449	0.0135	control	Spring	12	
C108	108	5	0.0505	0.0109	control	Spring	12	
C108	108	6	0.0552	0.0041	control	Spring	12	
C109	109	1	0.0642	0.0107	control	Spring	12	
C109	109	2	0.0572	0.0125	control	Spring	12	
C109	109	3	0.0445	0.0101	control	Spring	12	
C109	109	4	0.0439	0.0073	control	Spring	12	
C109	109	5	0.0406	0.0104	control	Spring	12	
C109	109	6	0.0446	0.0150	control	Spring	12	
C110	110	1	0.0822	0.0060	ovx	Spring	3	Summer
C110	110	2	0.0798	0.0052	ovx	Spring	3	Summer
C110	110	3	0.0789	0.0083	ovx	Spring	3	Summer
C110	110	4	0.0732	0.0096	ovx	Spring	3	Summer
C110	110	5	0.0624	0.0108	ovx	Spring	3	Summer
C110	110	6	0.0687	0.0058	ovx	Spring	3	Summer
C111	111	1	0.0752		ovx	Spring	12	
C111	111	2	0.0504		ovx	Spring	12	
C111	111	3	0.0547		ovx	Spring	12	
C111	111	4	0.0762		ovx	Spring	12	
C111	111	5	0.0623		ovx	Spring	12	
C111	111	6	0.0587		ovx	Spring	12	
C112	112	1	0.0808		ovx	Spring	12	
C112	112	2	0.0750		ovx	Spring	12	
C112	112	3	0.0777		ovx	Spring	12	
C112	112	4	0.0775		ovx	Spring	12	
C112	112	5	0.0776		ovx	Spring	12	
C112	112	6	0.0846		ovx	Spring	12	