Relationship between organ weight and cause of death of stranded porpoises

Pathological use of organ weights

Utrecht University

van hall larenstein
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Linda Grim 860512002

A thesis of the study Animal Management in 2016 at Van Hall Larenstein, under the guidance of

Lonneke IJsseldijk and Prof. Dr. Andrea Gröne of Utrecht University

First supervisor: Corine Oomkes

Second supervisor: Monique den Heijer

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Preface

I learned a lot during my study. All this knowledge and experience will be incorporated into my thesis. There were lots of ups and downs in study, but after all I finally made it.

My thesis at the Department of Pathobiology of the Veterinary Faculty of Utrecht University is related to the pathology of harbour porpoises. During the writing of my thesis, I was supervised by Mrs den Heijer, Mrs. Oomkes, Mrs. IJsseldijk and Mrs. Gröne, for which I thank them.

Linda Grim

March 2016

Summary

The Department of Pathobiology of the Veterinary Faculty at the University of Utrecht is investigating the causes of the death of stranded porpoises. The causes of death of porpoises are assessed by internal and external investigation at the Utrecht University. At dissections, the organs of the dead porpoise are extracted and weighed to determine the cause of death. The Faculty of Veterinary Medicine at the University of Utrecht has weighed the organs for years but to this day do not know why. Therefore, they find it important to do research into the purpose of weighing these organs. The aim of this investigation is to gain insight into the function of the weighing of organs from a dead porpoise within pathological context. Through this investigation, a recommendation will be given to Utrecht University about continuing the weighing of organs from dead porpoises. The relationship between the weight of the organs with the cause of death of the animal is hereby central. The data used for this investigation is collected from the existing data of the Department of Pathobiology from research into the human related causes of death of the Harbour Porpoise that have washed up on the shores of the North Sea. In addition to the data of the University Utrecht, a literature study about mean values of organ weights of porpoises and a survey of other pathology institutions was done. To calculate the correlation between the weight of organs and the body weight of porpoises from the data of Utrecht University, the Pearson correlation was used. As a control, scatter plots were created. The results of the literature study were analysed and compared with each other. In conclusion the weight of the various organs and the body weight of porpoises have an adequate to significant correlation. No relationship between the weight of organs and the cause of death of porpoise is found. The advice to Utrecht University to not continue weighing the organs of the stranded porpoises.

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1. Introduction

Pathology is the knowledge of diseases and their causes. Pathology studies the origin (etiology), cause (pathogenesis), process (pathophysiology), the specific form and the effects of a disease.(1) Dissections are part of pathology. Dissection means to remove the organs to evaluate them. Every organ from a dead body is removed and weighed. It is not known whether weighing organs has a pathological use. After the organs are removed and weighed, they will be sectioned and histological slides will be prepared. Histological abnormalities of the organs can determined by visual assessment at the microscopic level.(2)

Prof. Andrea Gröne is a professor at Utrecht University (UU) at the Department of Pathobiology and Veterinary Pathology Diagnostic Centre (VPDC) and has commissioned the investigation into the relationship between the weight of organs and cause of the death of harbour porpoises.(3) The Department of Pathobiology focus on research in the field of physiology, anatomy, pathology and pathobiology. The mission of this department is to collect and disseminate knowledge about the function and dysfunction of tissues, cells and organs.(4) At the request of the Dutch Ministry of Economic Affairs the Department of Pathobiology is investigating the death of porpoises which have stranded in the Netherlands. This allows them to gain insight into the proportion of human influences as a cause of death of porpoises.(5) Hereby the organs of the dead porpoises are weighed and the organ weight is noted.

Porpoises are endothermic cetaceans and belong to the order *Cetacean*. With a length of 1.80 meters and weighing about 60 kilograms the harbour porpoise is a small cetacean with a life expectancy of eight to twelve years. The harbour porpoise lives alone or in small groups of two to ten animals, usually mothers and calves. Sexual maturity is reached after three to four years after which females generally become pregnant every one to two years. The main food sources of porpoises is small, schooling fish and cephalopods animals such as shrimp.(6) Porpoises have a layer of fat that protects their organs against the cold waters they live in. Mammals on land have a coat, which aquatic animals do not have, instead they have blubber.(7) The blubber is sub-epidermal and provides a mechanism for regulating heat and storing fat as a reserve energy source.(8) The blubber thickness is measured in millimetre and is an indicator of the nutritional status of the animal.

Stranded porpoises are found in the Netherlands and these strandings have several main reasons. Porpoises washed ashore are not always dead; the live, but diseased ones can sometimes be treated and returned to the sea. The porpoises which are found dead are often used to study the cause of death. Examples of common causes in Netherlands are; human impacts such as by-catch (20%), attacks by grey seals (20%) and infectious diseases (18%). These percentages are indications and have several uncertain factors. Determining the cause of death always has some uncertainty, since it is not always 100% clear what the exact cause of death is. The category by-catch is for example divided in multiply sub-categories, from certain by-catch to possible by-catch. Determination whether the cause of death is indeed by-catch, is then performed by exclusion of other death-factors. Thereby factors of uncertainty arise, because there is actually no proof that the cause of death was by-catch unless the animal is taken from a net. It is only proven that it was not one of the other investigated causes of death. The table below shows the percentages of different causes of death from 879 porpoises which were found during an investigation of post-mortem examination of

porpoises in Dutch waters from 2009 to 2013 from the Department of Pathobiology of Utrecht University.(5)

Table 1: Percentages of causes of death of 879 porpoises washed ashore in the Netherlands. The percentages are from an annual report of post-mortem examination of porpoises in Dutch waters from 2009 to 2013 from the Department of Pathobiology of Utrecht University. These causes of death are included in this investigation as a variable.

Cause of death	Percent %
By-catch	20
Attacks by grey seals	20
Infections (by parasites, viruses, and bacteria)	18
Emaciation (long time not enough food)	14
Starvation (no food)	8
Other (for example, blunt trauma)	5
Unknown cause of death	15

Reference: L. Begeman, L.L. IJsseldijk, Prof. Dr. A. Gröne ," Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013"

The causes of death of porpoises are assessed by internal and external investigation at the Utrecht University. During the external investigation, the sex, the body weight and age are determined. Photos of the animal are taken. The location and the date of stranding are noted. Also the state of decomposition is noted. During the internal investigation, all organs are viewed, identified and sampled. Also every organ is weighed. Samples are collected for viral, histological, bacteriological and toxicological testing. The diet of the animal can be determined with the investigation of the stomach contend. This may help to determine the cause of death. Skin samples are also taken for genetic tests. The dissections of the porpoises are performed according to the protocol of Kuiken & García Hartmann from the year 1999.(5)

The Department of Pathobiology of Utrecht University has weighed the organs of porpoises for years, it is however not known whether this practice is useful. It is unknown if the weight of the organs can support the endeavour to determine the cause of death. Weighing the organs takes time, effort and money, therefore, it is important to do an investigation into the relationship between organ weight and cause of death of porpoises.

The aim of this research is to gain insight into the function of weighing organs of dead porpoises within pathological context. Through this research, advice can be given to the Department of Pathobiology of Utrecht University about continuing the weighing of organs from dead porpoises. This investigation will provide the Department of Pathobiology insight about a possible relationship between the weight of organs and cause of death of stranded porpoises.

The main question of the research is: What relationship is there between organ weight and cause of death of stranded porpoises?

The sub-questions of this research are:

1. What is the average weight of each organ of porpoises?

2. What correlation exists between body weight and the weight of the various organs of stranded porpoises?

3. What is the average weight of each organ of the stranded porpoises in relation to cause of death?

In the following paragraphs, the materials and methods, results, discussion and conclusion will be laid out. The chapter materials and methods describes the methods which were used for this investigation grouped into survey and the three sub-questions. The chapter results shows de results of the survey, the literature study and data of Utrecht University grouped into survey and the three sub-questions. In the chapter discussion the results are discussed and the chapter conclusion gives the answer on the research question. At least a recommendation is given for the Utrecht University about continuing weighing organs.

1.1 Concept definition

Atypical words and common terms are explained in this chapter. Atypical words are words that deviate from the norm.(9) The words are in alphabetical order and there is a word given a short explanation.

Data: with data, the data on sex, age, nutritive condition, blubber thickness, body weight, organ weights and the cause of death of porpoises is intended.

Main organs: with main organs, the heart, kidneys, long, brain, pancreas, stomach and intestine are intended.

MesLN: is the Mesenteric Lymph node.

PulmLN: is the Pulmonary Lymph node.

Sample: a sample is a random measurement and does not include the entire population.(10)

2. Material and methods

This chapter explains how the information was acquired for this investigation, what resources were needed and which methods were used grouped into survey and the different research questions.

The data for this investigation is collected from a survey of pathological institutes and a literature study. Furthermore, data was provided by the Department of Pathobiology of the University Utrecht from their investigations into causes of death in stranded porpoises.

The data from the Department of Pathobiology contains the body weight (kilogram), organ weight (gram), age, blubber thickness (mm), nutritive condition, sex, state of decomposition and cause of death of porpoises as determined by dissections on stranded porpoises. In appendix I, a short description of the main organs is given as well as their main functions. Animals are grouped in three age categories; infants <90 cm, juvenile 90-130cm or adult >130cm. Also the state of decomposition is noted in five categories; 1 (very fresh) to 5 (very rot). The Nutritive Condition Code is grouped into 1 (very good) to 6 (very bad). This data consist samples from fresh (<24 hours of death) harbour porpoises from 2009 to 2013. Cause of death from porpoises which were dissected after 24 hours are not reliable, because of their rotting status. In a further state of decomposition, it is difficult to determine a cause of death.(5) The blubber thickness has an insulating function, even for some time after the death of the animal. Therefore bacteria have an optimum temperature to grow and accelerate the decomposition of an animal.(11) For this investigation, the data of 59 porpoises whose cause of death is known was used. In table 2 the number of values from the different organs of porpoises are presented.

Table 2: This table shows the number of values from the different organs of porpoises. The Pulmonary Lymph node is abbreviated with PulmLN and the Mesenteric Lymph node with MesLN. The data is from the investigation; “Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013” from the Utrecht University.

Organ	Number of values
Lung Left	52
Lung Right	52
Heart	51
Pancreas	53
PulmLN	48
MesLN	51
Spleen	51
Kidney Left	59
Kidney Right	59

Organ	Number of values
Liver	59
Adrenal Left	59
Adrenal Right	58
Brain Left	21
Brain Right	12
Stomach	53
Gonads Left	37
Gonads Right	38

2.1 Survey

A survey was done to provide more insight about other institutions and their manner of performing dissections, weighing organs of dead animals and the reason why they do or do not weigh organs. Also a short survey was performed to find information about human and veterinary pathology. The surveys were done by searching on World Wide Web with the search engine Google by using the terms "Veterinär Institute" and "Veterinär Pathologie" in German, "Veterinair Pathologie" in Dutch

and "Verterinary pathology" and "Veterinary pathology institute" in English. A sample of different human and veterinary pathology institutes in various countries were contacted such as the Institut für Pathologie und gerichtliche Veterinärmedizin Wien (Austria) and the Norwegian Veterinary Institute of Tromsø. The institutes which showed up first on Google and had an email contact were chosen. Email contact was chosen to prevent language problems and because of effectiveness. To get in contact with many institutes, email is a quick and easy method. In the appendix II, the text of the emails is presented.

This survey helps to give an advice to the Department of Pathobiology of Utrecht University about continuing the weighing of organs from dead porpoises.

2.2 What is the average weight of each organ of porpoises?

To answer this research question, a literature study was done to collect data on organ weights with respect to cause of death, the normal weight of organs, similar studies and the weights of organs from dolphins (similar species). With the terms in Table 3, on PubMed (digital library for scientific articles), Google search engine and Google Scholar were searched for information.

Table 3: Overview of search engines and terms used for the literature study.

Search engines	Terms in German	in English	in Dutch
Google/Google Scholar	Gewicht Organe Schweinswal	Porpoises weight organs	Onderzoek naar orgaan gewicht bruinvissen
	Forschungen Schweinswal Organe	Weight organs dolphin	Verhongering gewicht organen
		Starvation weight organs	Vermagering gewicht organen
		Emaciation weight organs	Infectieuze ziekten gewicht organen
		Infectious disease weight organs	Gewicht organen dolfijn
		Correlation organ weights and cause of death	Gewicht organen bruinvis
		Starvation physiology	
		Emaciation organ weight	
Pubmed	Gewicht Organe Schweinswal	Cetacean organ weights	Onderzoek naar orgaan gewicht bruinvissen
	Forschungen Schweinswal Organe	Porpoises weight organs	Verhongering gewicht organen
	Menschliche Organe	Weight organs dolphin	Vermagering gewicht organen
	Forschungen zusammenhang von Organen und Todesursache	Starvation weight organs	Infectieuze ziekten gewicht organen
		Emaciation weight organs	Clostridum
		Infectious disease weight organs	Onderzoek naar gewichten van organen van bruinvissen, dolfijnen en mensen
		Adenovirus	
		Anello Virus	
		Correlation organ weights and cause of death	
		Starvation physiology	
		Emaciation organ weight	

Based on the short summaries that are present on websites and articles, a choice was made whether a resource is usable or not. The website or the article was read and a decision was made if the

information was useful for this investigation. Relevant abstracts of articles contain information about organ weights with respect to cause of death, the normal weight of organs, similar studies and the weights of organs of dolphins (similar species). The information was reliable if the articles were recent and published in a scientific journal with a good impact factor. In this case, recent article are from the year 2000 or later. If it comes to factual information, it is not important that the article is recent. In that case it was important that the scientific journal which published the article had a good impact factor. An impact factor shows the importance of a science journal. The average number of citations of an article is the measurement of the impact factor of a journal. Journals with a higher impact factor are deemed more important and have articles of higher scientific value.(12) On this basis, a selection is made from items that contain relevant information which can help answering the research questions from this investigation. This ensures that the information used for this investigation is valid.

Books were also used for information about porpoises. The thesis "Fishing for food" by Okka Eike Jansen and the books "The biology of the harbour porpoise" by AJ Read, “Whales and Dolphins" by T. Day, and "Porpoises" by AJ Read were used. These books contain information that is relevant for this investigation. In this case, relevant information included background information about porpoises, dolphins and the anatomy of porpoises and dolphins.

2.3 What correlation exists between body weight and the weight of the various organs of stranded porpoises?

To calculate the correlation between the organ weight and the body weight of the data of Utrecht University, the Pearson correlation calculation was used. With the Pearson correlation, the relationship between two numbers can be calculated. The degree of correlation is displayed with the correlation coefficient. Thereby the significance of the correlation can be determined. With the Pearson correlation, the organ weight relative to the body mass was calculated. The significance of the correlation was also determined with this calculation. With the Pearson correlation, deviations in the weight of organs are identified. As a control, scatter plots were created so that the correlations can be presented visually. The central (the extent of the point cloud which tends to be a line) line shows the degree of correlation.(13)

2.4 What is the average weight of each organ of the stranded porpoises in relation to cause of death?

To answer this research question, the mean values of organ weights were grouped into two categories; extern and intern causes of death. The category “extern” means that porpoises died from an external influence and the “intern” category means that porpoises died from internal problems. The category “extern” contains the following causes of death; by-catch, attacks by grey seals and others. The category “intern” contains the causes of death; infections, emaciation and starvation. The mean values of both categories are also grouped in adults, juvenile and neonates. This is because of the different lengths of the porpoises. These mean values of organ weights are compared with the mean values of organ weights of the literature study to determined differences in the weight of organs. Also the mean values of organ weights from all 59 porpoises was calculated, grouped into adult, juvenile and neonates, without dividing them in intern and extern cause of death. They are further grouped in female and male. These mean values can be found in the appendix III. All mean values were calculated using the Microsoft Excel program.

2.4.1 Extern causes of death

In this category the porpoises died from external factors. In these animals it is expected that the organs have a normal weight such as in a healthy animal.

By-catch: the category by catch is grouped in four sub-categories; probable by-catch, highly probable by-catch, possible by-catch and certain by-catch. In order to make this data easier to process, the four categories were summarized into one category.(5)

It seems that the amount of porpoises which died from the cause of death “by-catch” is higher in March and September than in other months. This is determined by an investigation of the department pathobiology. The diagnosis of by-catch is often made with the exclusion of other causes of death. Another indication for by-catch is the presence of printings from nets. These are often found on the fin as cuts. Also the good condition of the animal is an indication.(5)

At porpoises which are by-caught, pulmonary oedema is presence. This is because the cause of death by by-catch is asphyxiation.(5)

Attacks by grey seals: Scientists from the Royal Netherlands Institute for Sea Research identified DNA of grey seals in bite wounds of porpoises. A theory of the scientists is that, the grey seals see porpoises as prey because of their fat.(14) Thereby the cause of death “attacks by grey seals” was added as a category in the year of 2013 because of these findings. Old photos of the death porpoises which were found in the last years were checked again. They were subsequently added to the category “attacks by grey seals” when the dead porpoises showed the same wounds as the porpoises with the DNA of grey seals in their wounds.(5) The victims of grey seals are found mainly in the winter months, especially February and March.(5) This may be associated with birth of grey seals and the demand for more food or protecting their young. Grey seals give birth in the months from November to March, depending on the region the seals live in.(15)

Other: In this category the causes of death are blunt trauma, propeller trauma and dystocia.(5) Blunt trauma and propeller trauma are more often because of the increase of maritime traffic.(16) Dystocia is a difficulty childbirth which led to the death of mother and child.(17)

2.4.2 Intern causes of death

In this category the organs of the porpoises presumably can have a different weight than in a healthy condition. Such as, for example, at starvation can initiate fatty degeneration, increasing the weight of liver.

Starvation and emaciation can have an indirect external cause such as overfishing, but for this investigation, this was not taken into consideration.

Infections: At the Department of Pathobiology, various infections have been studied. The study concluded that adult animals more often have infections as a cause of death than juvenile animals. Also infectious diseases were mainly found in adult females throughout the year. Porpoises have often parasites in their ears *(Stenurus minor)* (18)*(Nematode; roundworm)*), lungs *(Seudalius inflexus)*(19), liver *(Campula oblonga)*, stomach *(Pholeter gastrophilus)*(20), pancreas and intestine *(Diphyllobohrium stenimacephalum)*(21).(5) Also *Clostridium spp.* were found in dead porpoises. Diarrhoea is a consequences of infections which the gram positive bacteria *Clostridium* occurs.(22) It

often occurs as a consequence of post-mortem growth of this bacterium. In the investigation of viruses, it has been found that there are two viruses are causing death of porpoises, the adenovirus and the anello virus. The adenovirus can infect dividing and non-dividing cells of a large variety.(23) The anello virus is found in several vertebrate species. It is a DNA virus group of single-stranded circular DNA.(24)

Emaciation: Emaciation is a process of thinning of an animal. In this category porpoises were not able to find enough food in a long time (days/weeks to months). The animal is hereby losing a lot of weight and the organs are losing weight as well. The diagnosis of this finding is hard because often there is no clear evidence for the exact cause of death. It is assumed that an animal is emaciated with a blubber thickness less than one centimetre. Harbour porpoises can die from hypothermia, due to the lack of isolation from the cold water. Emaciation is thus assigned to animals with a very thin layer of blubber, why other causes of death are unlikely.(5)

Starvation: Starvation means that an animal is not able to find any food for several days. The animal can starve without losing weight. The most susceptible porpoises are new-born because of immature terms of metabolism and its large surface area in relation to their body content. The category of starvation as a cause of death is therefore diagnosed mainly in new-borns. The diagnosis can be made by finding the presence of ulceration of the stomach and renal and hepatic lipidosis (fatty degeneration of the kidney and liver). It is expected that kidney and liver increase in weight. Also the absence of stomach/intestinal content is an indication of the cause of death of starvation. Starvation of new-borns can be caused by a mother who produces a small amount of milk, or because new-borns and mother are separated from each other, for example, by a disruption of the habitat.(5)

3. Results

In this chapter the results of the survey, the literature study and the analyses from the data of the Utrecht University are presented. The survey shows the results from different institutes which were questioned. The literature study shows the results of three different articles which investigated mean values of organ weights from different animals. The data of Utrecht University is presented in tables and texts. This data include 59 porpoises which were stranded on the Dutch coast. The research population consists of 18 adults (12 female, 6 male), 32 juvenile (11 female, 21 male) and 9 neonates (4 female, 5 male).

3.1 Survey

In the survey performed, different human and veterinary pathology institutes where questioned about weighing organs during dissections. The questionnaire revealed the procedure of dissections. In the following table 4, an overview is given of the results. This table gives an overview of the answers that pathology institutes gave about weighing the organs and why they do or do not weigh the organs.

Table 4: Overview of the survey of human and veterinary pathology institutes. This table shows the institutes which gave an answer on the questions of the survey. This table gives an overview of the answers of institutes gave about weighting the organs of animals or humans and why they do or do not weigh the organs.

Institute	Human\Veterinary	Organs are weighed?	Why not\Why
Dept. Life Sciences & Technology Van Hall Larenstein Netherlands	human	yes	standard during autopsy
Veterinärmedizinische Universität Wien Austria	veterinary	no	Not standard, only when expected to be useful
Institut für Veterinär-Pathologie Giessen Germany	veterinary	no	Only in special cases
Gezondheidsdienst voor Dieren (GD) Netherlands	veterinary	no	no comment
Veterinär Pathologie München Germany	veterinary	no	Sometimes with altered organs (with tumour)
Norwegian Veterinary Institute Norway	veterinary	no	Just in special cases

None of these veterinary institutions weighed the organs. In many answers of the veterinary institutions, it appeared that in special cases the organs are weighed. If there is a visual defect such as hypertrophy or hypotrophy the organs are weighed. The Veterinär Pathologie München often weighs the heart of dogs and cats. This is because of heart changes were associated with an increase in heart weight. The heart weight can be put in relation to body weight (relative heart weight), so that hypertrophy can be detected.

One of the pathologists of the Veterinär Pathologie München explained that not weighing the organs has to do with the missing norm values of the animals. That human is one specie, which makes it possible to get norm values. In contrast, the pathologist explained that animals have many subspecies and breeds. As an example dogs, dogs have many different breeds with different sizes(25), making it extremely difficult to get norm values for every breed.

At the Institute for Pathology und gerichtliche Veterinärmedizin Wien, about once a year the decision is made to weigh the organs. This occurs if there is a visual abnormally of an organ.

In the human pathology, the practice of the weighing organs is standard. In the book "A Lehr- und Nachschlagebuch: Band 1: Rechtsfragen in der Pathologie in" explains how a dissection is performed on humans. It describes that each organ is removed and weighed.(26) With the norm values of the human organs, it is possible to determine differences in organs by weight.(27) Also norm values of organ weights can be used for other studies.(28)

3.2 What is the average weight of each organ of porpoises?

In this chapter the results of the literature study are presented.

There are several studies on the weight of organs of various animals.(29) For this research, three studies about mean values of organ weights were found.(30)(31)(32) These three studies investigate the organ weights of non-captive dolphins, bottlenose dolphins and harbour porpoises. These articles helped to compare and discuss the results from the data of Utrecht University.

Porpoises are endothermic cetaceans and belong to the order *Cetacean*. They have the same evolutionary origin as dolphins. Dolphins are closely related to porpoises and therefore chosen for this investigation into the relationship between organ weight and the cause of death of porpoises. Both dolphins and porpoises are descendants of terrestrial mammals, most likely of the order of ungulates.(33). As well as dolphins porpoises are classified as whales with teeth *(Odontocetes)*.

In an investigation of the organs weight of non-captive porpoises *(Stenella spp.)* by William F. Perrin and Edward L. Roberts in 1972, the weights of the heart, liver, kidney and spleen of 68 eastern Pacific spotted dolphins and 14 eastern Pacific spinner dolphins were determined. Nowadays, *Stenella spp.* belongs to the family of dolphins *(Delphinidae)* and is determined not to be a subspecies of porpoises.(34) During tuna season operations in the Pacific Ocean these animals were accidentally killed and then used for the investigation of organ weights of non-captive dolphins *(Stenella spp.)*. The aim of this study was to get information about norm values which can help with the evaluation of the post-mortem condition of animals which died in captivity. These animals were also investigated for their physiology and biology. With Log-Log regression analyses, the correlation between organ weight and body weight was calculated. The important results for the investigation into the relationship between organ weight and cause of death of stranded porpoises are shown in table 5 and table 6. These tables show the range of the weights of the organs, the age and the range of the body length of two subspecies of *Stenella*. In this case it refers the two subspecies *Stenella graffmani* and *Stenella longirostris*. First the results of *Stenella graffmani* are presented in table 5 and the results of *Stenella longirostris* are presented in table 6. In table 6 data is missing such as length and body weight of an adult porpoises.(30)

Table 5: This table gives an overview of the results of body weight (kilogram (kg)), body length (centimetre (cm)) and weight of organs (gram (gr)) from adults, calves and sub adults of subspecies *Stenella graffmani*. These results come from an investigation of the organs weight of non-captive dolphins *(Stenella spp.)*

Organ	Age	Body weight in kg	Body length in cm	Weight Organ in gr
Heart	Adult	55.5-84.0	180-200	236- 311
Lung	Adult	55.4-75.8	180-200	1642-2275
Liver	Adult	55.4-84.0	175-218	1281-2195
Kidneys	Adult Calves\Sub adults	55.4-84.0 23.6-53.2	175-218 129-178	426-968 129-178
Spleen	Adult Calves\Sub adults	55.4-84.0 40.4-53.6	175-218 154-178	20-65 24-100

Table 6: This table gives an overview of the results of ranges of body weight (kilogram (kg)), body length (centimetre (cm)) and weight of organs (gram (gr)) from adults, calves and sub adults of subspecies *Stenella longirostris* These results are from an investigation of the organs weight of non-captive dolphins *(Stenella spp.)*

Organ	Age	Body weight in kg	Body length in cm	Weight Organ in gr
Heart	Adult	43.5-59.0	168-177	191-272
Lung	Calves\Sub adults	18.1-33.6	118-149	599-1112
Liver	Adult	43.5-59.0	168-177	832-997
Kidneys	Adult	43.5-59.0	168-177	289-393
Spleen	Adult	-	-	13-31

A study to the weight of organs of Bottlenose Dolphins *(Tursiops truncatus)* provides mean values for the organs of bottlenose dolphins. In the year of 1991 to 2003 bottlenose dolphins stranded along the Texas and Louisiana coasts in north-western Gulf of Mexico. This research has the goal to make a table which present the baseline data for organ weights of bottlenose dolphins. With this table, abnormalities in sizes of organs can be identified. On 63 freshly dead animals (< 24 h), dissections were performed to get information about length, gender, sexual maturity status, body weight, organs weight and age. The animals were grouped in three length categories; < 175 cm (n = 7; 5 females and 2 males), animals between 175 and 225 cm (n = 20; 9 females and 11 males) and > 225 cm (n = 36; 17 females and 19 males). In table 7 the mean values of bottlenose dolphins with different length in centimetre and mean weight in gram of different organs are presented.(31)

Table 7: This table shows an overview of the mean weight of the organs bottlenose dolphins. These values come from an investigation to Organ Weights and Growth Profiles in Bottlenose Dolphins *(Tursiops truncatus)* from the North-western Gulf of Mexico. The table shows three groups with different length (centimetre (cm)) and their mean values of weight (gram (gr)) of different organs.

Organ	**Length <175 cm**	**Length 175-225 cm**	**Length >225 cm**
Heart (gr)	262.8	452.1	940.3
Liver (gr)	978.3	2,546.9	4,304.5
Kidenys (gr)	296.0	615.7	1,209.3
Lung (gr)	1,346.4	2,542.4	6,108.7
Brain (gr)	909.1	1,332.2	1,471.7
Pancreas (gr)	134.1	209.9	364.2
Spleen (gr)	60.8	73.4	92.9

During an investigation of Ontogenetic allometry and body composition of harbour porpoises *(Phocoena phocoena, L.)* from the western North Atlantic, the data of different organs of calves, immature and mature porpoises were reported. These data are from porpoises which were accidentally killed during commercial fishing operations in the years between 1992 and 1998. The aim of this study was to get information about specific organ systems during growth and reproduction, the function of these organ systems and energetic requirements. Also body condition of these animals was investigated in detail for different reproductive classes. The body mass and the mass of different organs of 122 porpoises was noted. The porpoises were grouped into six reproduction classes. To compare six reproduction classes across mass distribution, two analyses were used; the ontogenetic allometry and the body composition technique. Individual body components can be described with the ontogenetic allometry. With the body composition technique, the percentage of mass from each organ of total body mass can be determined. In table 8, different organs with the mean weight in gram or kilogram are presented. These weights are from calves, immature males, mature males, immature females and pregnant non-lactating female porpoises. The organ weights are presented in mean weights with the range ±.(32)

Table 8: This table shows different organs and its average weights in gram (gr) or kilogram (kg) of calves, immature males, mature males, immature females and pregnant non-lactating females porpoises. This data comes from an investigation of Ontogenetic allometry and body composition of harbour porpoises *(Phocoena phocoena, L.)* from the western North Atlantic.

Organ	Calf	Immature male	Mature male,	Immature female	Pregnonlact
Heart (gr)	202 ± 47	256 ± 69	322 ± 62	283 ± 78	482 ± 154
Liver (kg)	0.59 ± 0.13	1.07 ± 0.24	1.38 ± 0.23	1.22 ± 0.27	1.99 ± 0.12
Kidneys (gr)	183 ± 29	271 ± 55	370 ± 61	297 ± 60	432 ± 49
Lung (kg)	0.68 ± 0.12	1.07 ± 0.23	1.48 ± 0.29	1.12 ± 0.25	1.83 ± 0.30
Brain (gr)	392 ± 34	466 ± 39	471 ± 41	452 ± 40	478 ± 25
Pancreas (gr)	55 ± 19	96 ± 25	108 ± 27	110 ± 29	144 ± 34
Spleen (gr)	7 ± 2	10 ± 4	9 ± 4	10 ± 5	16 ± 5
Stomach (gr)	236 ± 58	440 ± 145	598 ± 144	464 ± 128	780 ± 201
Intestine (kg)	1.15 ± 0.36	2.08 ± 0.41	2.34 ± 0.40	2.21 ± 0.40	2.73 ± 0.38

3.3 What correlation exists between body weight and the weight of the various organs of stranded porpoises?

The correlation between the weight of organ and the body weight of the 59 porpoises of the data of Utrecht University was calculated. To make the results measurable, they are divided into different categories: correlation and no correlation. The list of "correlation" means that there is a correlation between two variables, such as weight of an organ and the body weight of porpoises. The category "no correlation" contains all the results that have no correlation. This means the correlation is 29% or lower.

- 75% or higher correlation = There is a significant correlation.
- 60-74% correlation =There is a good correlation.
- 50-60% correlation = There is an adequate correlation.
- 30-49% correlation = There is a moderate correlation.
- 29% or lower correlation = There is an insufficient correlation with the risk of coincidence.

Scatterplots are used as a control of the Pearson Correlation and can be found in the appendix V.

In the table 9 (below), the correlations of different organ weights relative to the body weight of porpoises are shown grouped in “correlation” and “no correlation”. This is calculated with the Pearson Correlation which can be found in the appendix IIII.

Table 9: Overview of correlations of organ weights and body weight of porpoises calculated with Pearson Correlation grouped in "correlation" and "no correlation". The Pulmonary Lymph node is abbreviated with PulmLN and the Mesenteric Lymph node with MesLN. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of Utrecht University.

Organ	Correlation
Lung Left	0.893 (89.3%)
Lung Right	0.924 (92.4%)
Heart	0.947 (94.7%)
Pancreas	0.305 (30.5%)
Stomach	0.845 (84.5%)
MesLN	0.799 (79.9%)
Spleen	0.510 (51.0%)
Kidney Left	0.906 (90.6%)
Kidney Right	0.905 (90.5%)
Adrenal Right	0.722 (72.2%)
Adrenal Left	0.668 (66.8%)
Liver	0.856 (85.6%)
Brain Left	0.413 (41.3%)
Brain Right	0.887 (88.7%)
Gonads Left	0.499 (49.9%)
Gonads Right	0.460 (46.0%)

Organ	No Correlation
PulmLN	0.249 (24.9%)

The pancreas, with a percentage of 30,5%, shows a moderate correlation and the PulmLN shows with a percentage of 24.9% an insufficient correlation. The following two scatterplots contain the weights of the pancreas and the PulmLN relative to the body weight of porpoises. These scatterplots are shown because of their deviating value.

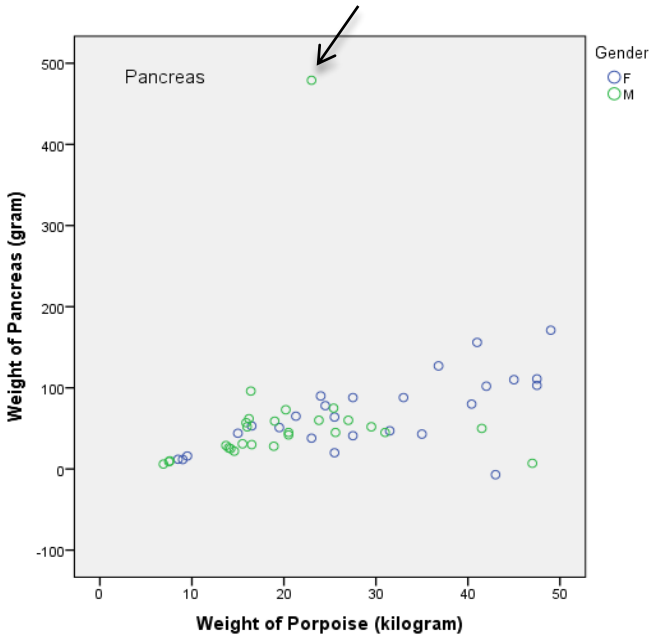

Figure 1: Weight of pancreas (gram) relative to the body weight (kilogram) of 53 stranded porpoises. This scatterplot shows a dense cloud of the points below 200 gram of the pancreas weight; just one point is above 400 gram weight of the pancreas. This point is marked with an arrow. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

The cloud of points shows the correlation of the weight of an organ relative to the body weight of porpoises. If the points are close together and form a line, it indicates a higher correlation. The scatterplot of the pancreas (figure 1) shows a dense cloud of the points below 200 gram of the pancreas weight; just one point is above 400 gram weight of the pancreas. This point is marked with an arrow in figure 1. The value of this point is 479 gram and comes from a juvenile male which was by-caught.

In the following figure 2 the scatterplot of the PulmLN is presented. This figure shows a dense cloud of points below 150 gram with the exception of one value, which is above 400 gram. This value is marked with an arrow in this figure 2. The value is from one measurement of PulmLN of 401 gram from a juvenile male which was categorized with an infectious disease.

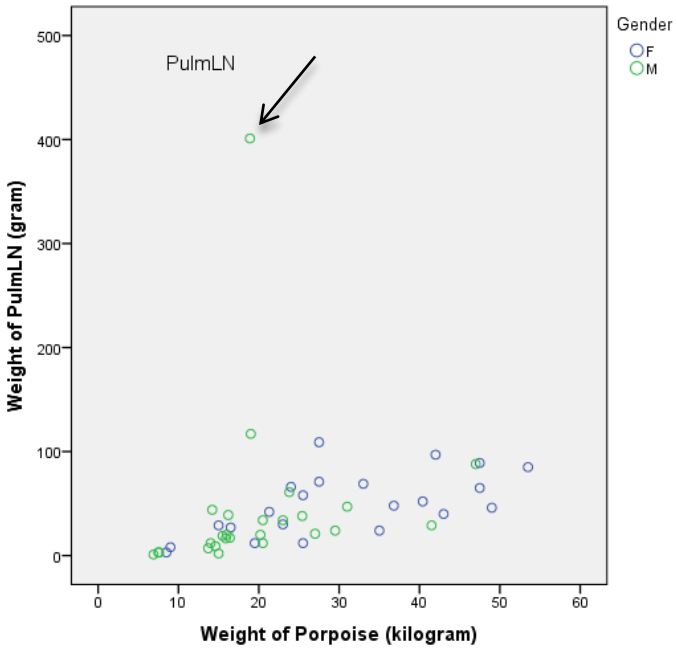

Figure 2: Weight of PulmLN (gram) relative to the body weight (kilogram) of 48 stranded porpoises. This scatterplot shows a dense cloud of points below 150 gram with the exception of one value, which is above 400 gram. This point is marked with an arrow. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

In figure 3, the scatterplot of the heart is shown. This figure shows a scatterplot of data with a good correlation. The heart has the highest significant correlation of al organs with a correlation of 0.947 (94.7%). The cloud of points is very dense and visually shows a significant correlation. The values are from 51 stranded porpoises.

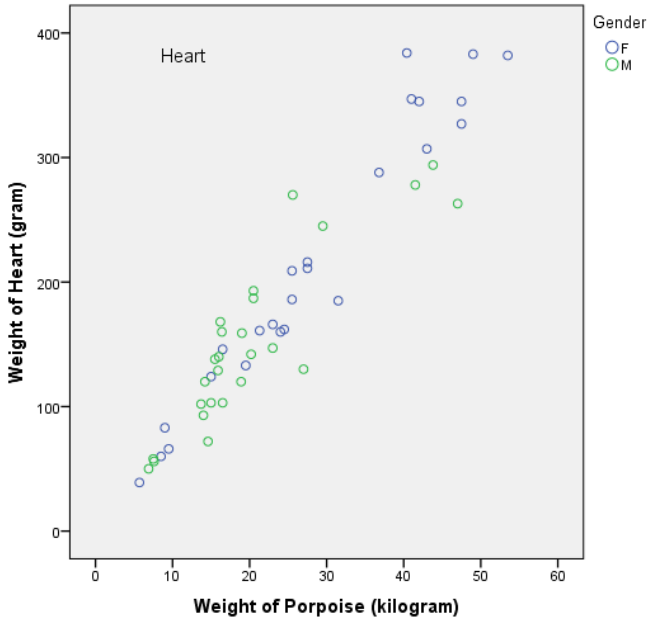

Figure 3: Weight of Heart (gram) relative to the body weight (kilogram) of 51 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

3.4 What is the average weight of each organ of the stranded porpoises in relation to cause of death?

In this chapter, the results of the mean values of the data from Utrecht University are presented in tables. The results are grouped into extern and intern causes of death. When the values are grouped into causes of death, some causes of death did not have enough values to calculate a reliable mean value.

The values are compared with values from the article "Ontogenetic allometry and body composition of harbour porpoises *(Phocoena phocoena, L.)* from the western North Atlantic" as described in the literature study of this investigation. The two categories extern and intern both show deviating values.

3.4.1 Extern causes of death

The results of the category "extern" are here presented. The category cause of death "other" has not enough values to calculate the average.

In table 10, shown below, the mean organ weights values from the cause of death "by-catch" grouped in adult, juvenile and neonate are shown. The organ weights are given in gram (gr). The values from the liver and the pancreas of the group "juvenile" show a deviation compared with the values of the liver and the pancreas from the article. The mean value of the liver (771.4 gr) is 51.4 gr heavier than the mean value of the liver from the article (590 ± 130 gr). Also, the mean value of the pancreas (94.4 gr) is 20.4 gr heavier than the mean value of the pancreas from the article (55 ± 19 gr). The value of the spleen (44.5 gr) group adult also shows a deviation. The spleen is 31.5 gr heavier than the mean value of the spleen from the article (9 ± 4 gr).

Table 10: Overview of different organ weights of harbour porpoises from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is shows the mean values of the cause of death "by-catch" and is grouped in adult, juvenile and neonate. The organ weights are given in gram (gr).

Organ in gr	Adult	Juvenile	Neonate
Heart	261.5	173.125	72.0
Liver	1202.5	771.4	432
Kidneys	305.5	201.97	49
Lung	1261.5	764.67	337
Brain	-	364	-
Pancreas	51	94.4	22
Spleen	44.5	6.22	3
Stomach	728.5	406.3	169

In table 11, shown below, the mean organ weights values from the cause of death "attacks by grey seals" grouped in adult, juvenile and neonate are shown. The organ weights are given in gram (gr). The values of the liver, lung, brain, spleen and stomach of juvenile porpoises shows a deviation compared with the article. The liver (884.29 gr) is 164.29 gram heavier than the mean values of the liver from the article (590 ± 130 gr). The lung (847.8 gr) is 47.8 gr heavier than the mean value of the lung from the article (680 ± 120 gr). The brain (563.33 gr) is 137.33 gr heavier than the mean value of the brain from the article (392 ± 34 gr). The spleen mean weight is 2 gr more than the mean weight of the spleen in the article (9 ± 2 gr). Also the mean weight of the stomach (594.0 gr) is 300 gr heavier than the mean weight of the stomach from the article (236 ± 58 gr).

Table 11: Overview of different organ weights of harbour porpoises from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is shows the mean values of the cause of death "attacks by grey seals" and is grouped in adult, juvenile and neonate. The organ weights are given in gram (gr).

Organ in gr	Adult	Juvenile	Neonate
Heart	340.33	164.5	93.0
Liver	1691.67	884.29	392.0
Kidneys	445.0	210.8	106.0
Lung	1924.67	847.8	503.0
Brain	512.0	563.33	-
Pancreas	102.0	68.8	26.0
Spleen	14.0	11.0	-
Stomach	-	594.0	139.0

3.4.2 Intern causes of death

In this chapter, the results of the category “intern” are given.

In table 12, shown below, the mean organ weights values from the cause of death “infections” grouped in adult, juvenile and neonate are shown. The organ weights are given in gram (gr). The heart, spleen and the stomach of the juvenile porpoises show a deviation compared to the article. The mean weight of the heart (140.83 gr) is 14.17 gr lighter than the mean value of the heart from the article (202 ± 47 gr). Also the spleen (4.25 gr) is 2.75 gr lighter than the mean weight of the spleen from the article (9 ± 2 gr). The average stomach weight(372.38 gr) is 78.38 gr more than the mean value of the stomach from the article (236 ± 58 gr).

Table 12: Overview of different organ weights of harbour porpoises from an investigation of “Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013” of the Utrecht University. The table is shows the mean values of the cause of death “infections” and is grouped in adult, juvenile and neonate. The organ weights are given in gram (gr).

Organ in gr	Adult	Juvenile	Neonate
Heart	320.75	140.83	66.0
Liver	1875.5	716.825	453.0
Kidneys	419.79	173.38	161.0
Lung	1484.0	571.75	-
Brain	505.75	422.67	261.0
Pancreas	99.78	48.13	16.0
Spleen	16.5	4.25	-
Stomach	888.64	372.38	71.0

In table 13, shown below, the mean organ weights values from the cause of death “emaciation” are shown. Since no emaciated adult or neonatal porpoises were present in the data, the only group for this cause of death is juvenile. The organ weights are given in gram (gr). The heart, lung and the spleen of the juvenile shows a deviation compared with the article. The mean weight of the heart (116.0 gr) is 39.0 gr lighter than the mean value of the heart from the article (202 ± 47 gr). The average weight of the lung (432.0 gr) is 128.0 gr lighter than the mean value of the lung from the article (680 ± 120 gr). Also, the mean spleen weight (3.0 gr) is 4 gr less than the mean spleen weight from the article (9 ± 2 gr).

Table 13: Overview of different organ weights of harbour porpoises from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is shows the mean values of the cause of death "emaciation" and is grouped in juvenile. The organ weights are given in gram (gr).

Organ in gr	Juvenile
Heart	116.0
Liver	641.5
Kidneys	189.5
Lung	432.0
Brain	392.0
Pancreas	57.0
Spleen	3.0
Stomach	260.0

The table 14, below, shows the mean values of organ weight of the cause of death "Emaciation" grouped in neonate. This cause of death has no values of adults and juvenile. The organ weights are given in gram (gr). The values of the neonate cannot be compared with values of the literature study, because of the no values of neonates are present in the article.

Table 14: Overview of different organ weights of harbor porpoises from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is shows the mean values of the cause of death "starvation" and is grouped in neonate. The organ weights are given in gram (gr).

Organ in gr	Neonate
Heart	62.75
Liver	324.0
Kidneys	92.25
Lung	273.25
Brain	273.5
Pancreas	9.68
Spleen	1.55
Stomach	58.13

The mean values of the data of the Utrecht University can be found in the appendix III. In table 1, mean values of the weight of organs from the 59 porpoises grouped in the categories adult, juvenile and neonate can be found. Table 2 shows the mean values of different female organ weights grouped in adult, juvenile and neonate. The male mean values of different organ weights are shown in table 3 also grouped in adult, juvenile and neonate. The organ weights are given in gram.

4. Discussion

In this chapter, the results of the investigation into the relationship between organ weight and cause of death of stranded porpoises are discussed. This investigation is commissioned by Utrecht University to find out if there is a use of weighing organs of stranded porpoises in pathological research.

The results of the survey show only in the field of human pathology the organs are always weighed while the organs of animals are only weighed is special cases. The Veterinär Pathologie München uses heart weight in relation to body weight to determine if a heart is hypertrophic. The data of this study can be used in the same way as the Veterinär Pathologie München uses data of the hearts of felines and canines to determine deviations of heart weight. By using the correlation between heart weight and body weight of porpoises, deviations in heart weight might be determined.(35) Also the results of the survey are not reliable, because just a few institutes replied. This can be explained with a small response rate that email surveys have.(36) To make the survey more reliable, more values are needed.(10) These results however can give an indication if institutes do or do not weigh organs, but it cannot be excluded that other institutes do weigh the organs of dead animals. Since this is only a sample of pathology institutes.

The results from the data of Utrecht University shows correlation between the weight of almost every organ and the body weight of porpoises. The pancreas and the PulmLN are the exception; these two organs have one divergent value. These values show moderate or insufficient correlation between organ weight and body weight of porpoises. The divergent value of the pancreas is from a porpoises which was by-caught. By-catch is categorized in the category of “extern” causes of death which means that none of the organ weight is expected to be divergent. The organ weights are not expected to be effected in any manner. Without the exceptional value the correlation is .597 (59.7%), an adequate correlation can be seen. The divergent value could mean that a mistake was made during weighing the organs or during the dissections. In a study about increase of the size of pancreas by eating disorders is explained that by underweighted people the pancreas was increased in weight.(37) This could be the same for porpoises and also explain the divergent value. The nutritive condition of the porpoises was a 4 (1 very good to 6 very bad). The divergent value of the PulmLN is categorized in the cause of death category “intern” which means that there is a possibility of a divergent organ weight, cause by the cause of death. Every other value of this organ categorized in the category “intern” has a good correlation. Without the exceptional value the correlation is .628 (62.8%), which is a good correlation. This divergent value is caused by a typing error. The weight of the PulmLN had to be 40.1 gram instead of 401 gram. This was found after an investigation of this divergent value by the Department Pathobiology.

The mean values of organs from the data of Utrecht University show some differences in organ weights of juvenile compared with the article “Ontogenetic allometry and body composition of harbour porpoises *(Phocoena phocoena, L.)* from the western North Atlantic”. The different lengths of calves between the studies might explain the difference in weight. The calves of that article have a length of about 111.9 ± 8.4 centimetre and the juvenile of the data of Utrecht University have a length of 90-130 centimetre.(32)(5) This could explain why the weights of organs differ. The study “Change Trends of Organ Weight Background Data in Sprague Dawley Rats at Different Ages” also shows that with age the organs will grow.(38) A study of normal internal organ weight of Thai adults

correlated to body length and body weight also shows that with increasing length the organs will be heavier.(39) Also one value of an adult porpoise in the study of the University of Utrecht shows a difference compared with the weight of the spleen of the article. This value is not reliable because of the lack values of the organ weights from adults with the cause of death “By-catch” of the data of the Utrecht University.(10)

The category “internal” cause of death has a greater possibility of abnormalities in organ weights then the external category. If an animal is for example emaciated it is expected that the organs such as the liver, decreases in size. The book “Marina Mammals” describes that when emaciated, atrophy of the hepatocytes, fat myocytes and myocardial cells can occur.(40) The data of the Utrecht University shows no abnormalities in the weight of the liver. The organ weights of the liver correlate as expected with the body weight. During starvation it is expected that the liver would be heavier because of fatty degeneration. When energy deficiency occurs, body fat will be broken down and deposited in the liver.(41) At the Utrecht University a fatty liver and kidneys is an indicator of starvation. The data of the Utrecht University shows no abnormalities in the weight of the liver of the kidneys. These organ weights also correlate nicely with the body weight. A reason can be that most of the porpoises stranded in the summer months, which mean they have a thinner blubber thickness and less fat which can deposit in the liver.(5)

5. Conclusion

The results of the survey show that in the human pathology, the organs are always weighed. The human pathology has norm values from every organ of the body with different size and body weight. This makes it possible to detect abnormalities in organ weights. The survey of the veterinary institutes shows that most organs are not weighed. Only in case of external abnormalities the organs are weighed.

In conclusion the weight of the various organs and the body weight of porpoises from the data of Utrecht University have an adequate to significant correlation, which means that the weight of organs is in proportion to the body weight of the porpoises. The calculated mean values of the data of Utrecht University showed, compared with the literature study, no abnormalities. This means that the organ weights show a good correlation to the body weight.

No relationship between the weight of organs and the cause of death of porpoises is found. It is recommended to not continuing weighing the organs of the stranded porpoises, only in the case of visual abnormalities of the organ. In this investigation, the mean values of the weight of organs of stranded porpoises were calculated, furthermore the mean values of organ weights were found by the literature study. These values can be used for further comparison of organ weights of porpoises.

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(49) Dr.M.J ter Voort, Drs. IJ. D. Jüngen. Medische fysiologie en anatomie. Houten, 2009

Appendix I

Every animal on this earth has organs which makes de body works. De main organs are the heart, the liver, the kidneys, the long and the brain. These organs carry out of the functions of the body. If one of these organs is damaged, the body cannot work probably. For this study every organ of the body is included. In the next section, the main organs, the pancreas, the stomach and the intestine are explained with their main functions.

Heart: takes care of the blood circulation of the body and of the lungs. It works autonomously and have specialized muscle cells which make excitations and pass them on. If this process did not work probably the heart gets out of rhythm (arrhythmia).(42)
Liver: takes care of the energy reserves, stores vitamins and carbohydrates. The liver regulates the glucose and fat metabolism. It produces bile and vital proteins. Also it detoxifies and metabolises nutrients.(43)

Kidneys: are controlling the blood pressure, regulate the fluid, acid-base and electrolyte balance. They detoxify the body and regulate the formation of red blood cells (erythrocytes). Also they regulate the bone metabolism.(44)

Long: is controlling the gas exchange between the blood circulation and the air we breathe. Pronounced uptake of oxygen and release of carbon dioxide from the body.(45)

Brain: stores information, coordinated behaviours and processed sensory impressions. It is split in two halves' with different functions. The right half of the brain thinks creative and nonverbal and recognizes colours, pictures and music. The left half of the brain thinks rational and logical. It controls the language centre and stores numbers. The cerebrum is responsible for acting, thinking, perception and emotions. The cerebellum controls the body balance.(46)

Pancreas: produces many digestive enzymes which digests proteins, carbohydrates and fats. Also it forms the hormones insulin and glucagon which regulate the blood sugar levels. Insulin is produced by the β-cells of the islets of Langerhans and decreases the blood sugar level. Glucagon increases the blood level is made by the α-cells of the islets of Langerhans.(47)

Stomach: turns food into a pulp by setting gastric juice, gastric acid (pH 1-1,5) and produces pepsin. The stomach acid is a 0.5% hydrochloric acid which can even degrade metals. The wall of the stomach is protected by a mucus layer. Chyme and food passes into the intestine, where they were digested.(48)

Intestine: takes care of digestion and absorption of vitamins, fat, proteins, salts and carbohydrates. The intestine is absorbs water and ensures the elimination of faeces.(49)

Appendix II

E-mail German:

Sehr geehrte Damen und Herren,

für meine Abschlussarbeit bin ich auf der Suche nach Informationen über das wiegen von Organen. Ich studiere Tiermanagement an der VHL in Leeuwarden und untersuche für ein niederländisches Institut den Zusammenhang von der Todesursache von einem Tier und dem Gewicht von seinen Organen.

Darum würde ich gerne wissen wollen ob Sie in Ihrem Institut die Organe von
toten Tieren wiegen und warum Sie das machen.?

Ich würde mich sehr über Antwort freuen.

mit freundlichen Grüßen

Linda Grim

E-mail English:

Dear Sir or Madame,

for my thesis I am looking for information about the weighing of organs. I'm studying animal management at the VHL in Leeuwarden, Netherlands. My thesis is about the relationship between organ weights and cause of death of stranded porpoises.
Therefore I would like to know if you weigh organs of animals and note the weights?

Best regards,

Linda Grim

E-mail in Dutch:

Goedemorgen,

voor mijn afstudeeropdracht zou ik graag willen weten of de pathologie afdeling tijdens
de dissecties het gewicht van de organen documenteert?
Mijn afstudeeropdracht gaat over de samenhang van het gewicht van organen en de doodsoorzaak van aangespoelde bruinvissen.

met vriendelijke groeten,

Linda Grim

Appendix III

Table 1: These table present different mean values of organ weights of porpoises grouped in adult, juvenile and neonatal. The organ weights are given in gram (gr). This data comes from of an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is grouped in female adult, female juvenile and female neonate. The organ weights are given in gram (gr).

Organ in gr	Adult	Juvenile	Neonate
Heart	305.6	154.60	64.11
Liver	1689.33	766.65	313
Kidneys	409	187.70	93.77
Lung	1496	671.90	282.38
Brain	581.83	498.80	322.17
Pancreas	82.67	68.87	14.09
Spleen	18.13	5.94	1.87
Stomach	948.53	400.73	79.17

Table 2: Overview of different organ weights of porpoises from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is grouped in female adult, female juvenile and female neonate. The organ weights are given in gram (gr).

Organ in gr	Adult Female	Juvenile Female	Neonate Female
Heart	312.20	166.30	55.00
Liver	1780.39	853.64	335.00
Kidneys	433.33	202.28	103.13
Lung	1507.67	814.77	215.17
Pancreas	103.46	57.46	13.23
Spleen	14.55	8.18	2.1
Stomach	976.82	392.13	63.88

Table 3: Overview of different organ weights of porpoises from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University. The table is grouped in male adult, male juvenile and male neonate. The organ weights are given in gram (gr).

Organ in gr	Adult male	Juvenile male	Neonate male
Heart	270.00	147.70	65.80
Liver	1452.6	731.63	721.08
Kidneys	386.00	180.40	82.2
Lung	1463.75	592.00	300.80
Pancreas	36.33	80.07	14.60
Spleen	32.00	4.64	1.75
Stomach	860.33	398.30	91.40

Appendix IIII

Table 1: Correlation between weight of Lung Right and body mass of 52 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	LongR
Bodymass	Pearson Correlation	1	.893**
	Sig. (2-tailed)		.000
	N	59	52
LongR	Pearson Correlation	.893**	1
	Sig. (2-tailed)	.000	
	N	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation between weight of Lung Left and body mass of 52 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	LongL
Bodymass	Pearson Correlation	1	.924**
	Sig. (2-tailed)		.000
	N	59	52
LongL	Pearson Correlation	.924**	1
	Sig. (2-tailed)	.000	
	N	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: Correlation between weight of Heart and body mass of 51 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Heart
Bodymass	Pearson Correlation	1	.947**
	Sig. (2-tailed)		.000
	N	59	51
Heart	Pearson Correlation	.947**	1
	Sig. (2-tailed)	.000	
	N	51	51

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4: Correlation between weight of Pancreas and body mass of 53 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Pancreas
Bodymass	Pearson Correlation	1	.305*
	Sig. (2-tailed)		.027
	N	59	53
Pancreas	Pearson Correlation	.305*	1
	Sig. (2-tailed)	.027	
	N	53	53

Table 5: Correlation between weight of Pancreas and body mass of 53 stranded porpoises without the exception value. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Pancreas
Bodymass	Pearson Correlation	1	.597**
	Sig. (2-tailed)		.000
	N	58	52
Pancreas	Pearson Correlation	.597**	1
	Sig. (2-tailed)	.000	
	N	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6: Correlation between weight of PulmLN and body mass of 48 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	PulmLN
Bodymass	Pearson Correlation	1	.249
	Sig. (2-tailed)		.088
	N	59	48
PulmLN	Pearson Correlation	.249	1
	Sig. (2-tailed)	.088	
	N	48	48

Table 7: Correlation between weight of PulmLN and body mass of 48 stranded porpoises without the exception value. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		PulmLN	Bodymass
PulmLN	Pearson Correlation	1	.628**
	Sig. (2-tailed)		.000
	N	47	47
Bodymass	Pearson Correlation	.628**	1
	Sig. (2-tailed)	.000	
	N	47	58

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8: Correlation between weight of Liver and body mass of 59 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Liver
Bodymass	Pearson Correlation	1	.856**
	Sig. (2-tailed)		.000
	N	59	59
Liver	Pearson Correlation	.856**	1
	Sig. (2-tailed)	.000	
	N	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 9: Correlation between weight of Adrenal Right and body mass of 58 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	AdrenalR
Bodymass	Pearson Correlation	1	.722**
	Sig. (2-tailed)		.000
	N	59	57
AdrenalR	Pearson Correlation	.722**	1
	Sig. (2-tailed)	.000	
	N	57	57

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10: Correlation between weight of Adrenal Right and body mass of 58 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	AdrenalL
Bodymass	Pearson Correlation	1	.668**
	Sig. (2-tailed)		.000
	N	59	58
AdrenalL	Pearson Correlation	.668**	1
	Sig. (2-tailed)	.000	
	N	58	58

**. Correlation is significant at the 0.01 level (2-tailed).

Table 11: Correlation between weight of Brain Right and body mass of 12 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	BrainR
Bodymass	Pearson Correlation	1	.887**
	Sig. (2-tailed)		.000
	N	59	12
BrainR	Pearson Correlation	.887**	1
	Sig. (2-tailed)	.000	
	N	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

Table 12: Correlation between weight of Brain Left and body mass of 21 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	BrainL
Bodymass	Pearson Correlation	1	.413
	Sig. (2-tailed)		.063
	N	59	21
BrainL	Pearson Correlation	.413	1
	Sig. (2-tailed)	.063	
	N	21	21

Table 13: Correlation between weight of Stomach and body mass of 51 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Stomach
Bodymass	Pearson Correlation	1	.845**
	Sig. (2-tailed)		.000
	N	59	53
Stomach	Pearson Correlation	.845**	1
	Sig. (2-tailed)	.000	
	N	53	53

**. Correlation is significant at the 0.01 level (2-tailed).

Table 14: Correlation between weight of Mes.LN and body mass of 51 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Mes.LN
Bodymass	Pearson Correlation	1	.799**
	Sig. (2-tailed)		.000
	N	59	51
Mes.LN	Pearson Correlation	.799**	1
	Sig. (2-tailed)	.000	
	N	51	51

**. Correlation is significant at the 0.01 level (2-tailed).

Table 15: Correlation between weight of Spleen and body mass of 51 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	Spleen
Bodymass	Pearson Correlation	1	.510**
	Sig. (2-tailed)		.000
	N	59	51
Spleen	Pearson Correlation	.510**	1
	Sig. (2-tailed)	.000	
	N	51	51

**. Correlation is significant at the 0.01 level (2-tailed).

Table 16: Correlation between weight of Kidney Right and body mass of 59 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	KidneyR
Bodymass	Pearson Correlation	1	.905**
	Sig. (2-tailed)		.000
	N	59	59
KidneyR	Pearson Correlation	.905**	1
	Sig. (2-tailed)	.000	
	N	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 17: Correlation between weight of Kidney Left and body mass of 59 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	KidneyL
Bodymass	Pearson Correlation	1	.906**
	Sig. (2-tailed)		.000
	N	59	59
KidneyL	Pearson Correlation	.906**	1
	Sig. (2-tailed)	.000	
	N	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

Table 18: Correlation between weight of Gonads Right and body mass of 38 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	GonadsR
Bodymass	Pearson Correlation	1	.460**
	Sig. (2-tailed)		.004
	N	59	37
GonadsR	Pearson Correlation	.460**	1
	Sig. (2-tailed)	.004	
	N	37	37

**. Correlation is significant at the 0.01 level (2-tailed).

Table 19: Correlation between weight of Gonads Left and body mass of 37 stranded porpoises. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

Correlations

		Bodymass	GonadsL
Bodymass	Pearson Correlation	1	.499**
	Sig. (2-tailed)		.002
	N	59	35
GonadsL	Pearson Correlation	.499**	1
	Sig. (2-tailed)	.002	
	N	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix V

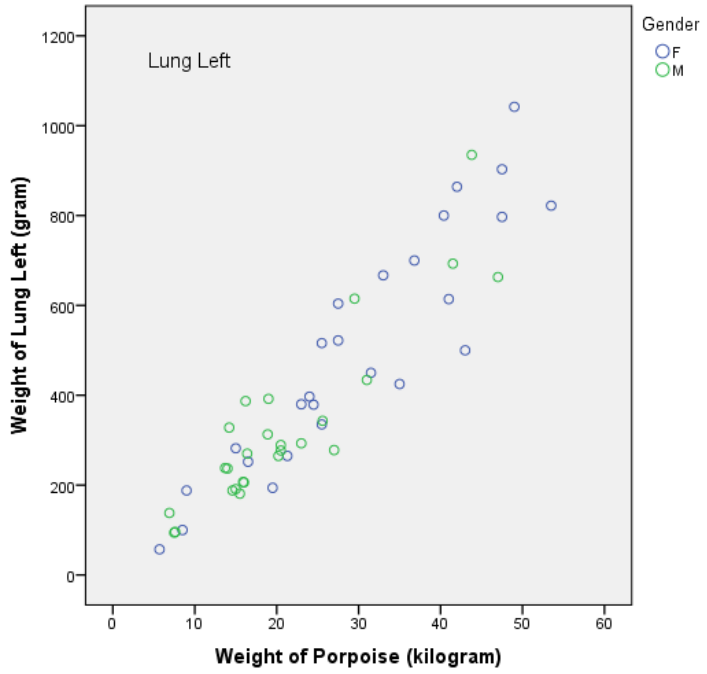

Figure 1: Weight of Lung Left (gram) relative to the body weight (kilogram) of 52 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

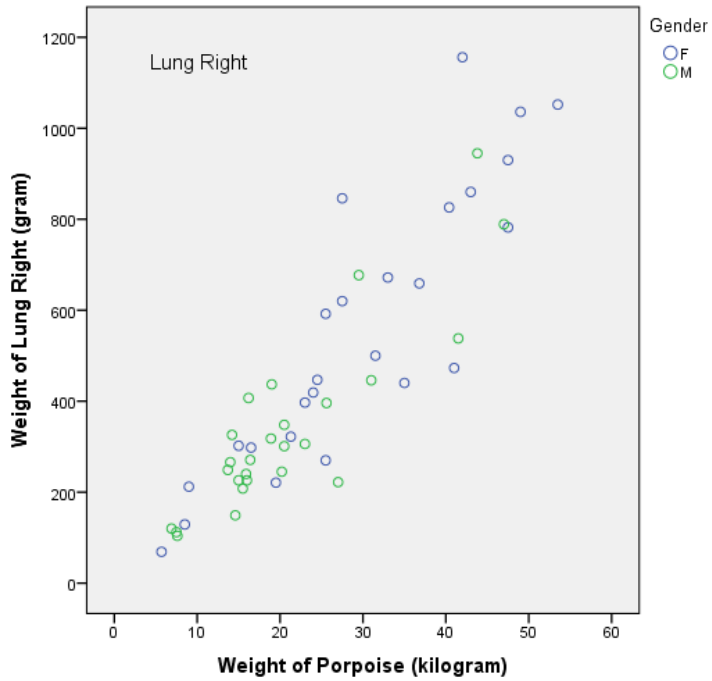

Figure 2: Weight of Lung Right (gram) relative to the body weight (kilogram) of 52 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

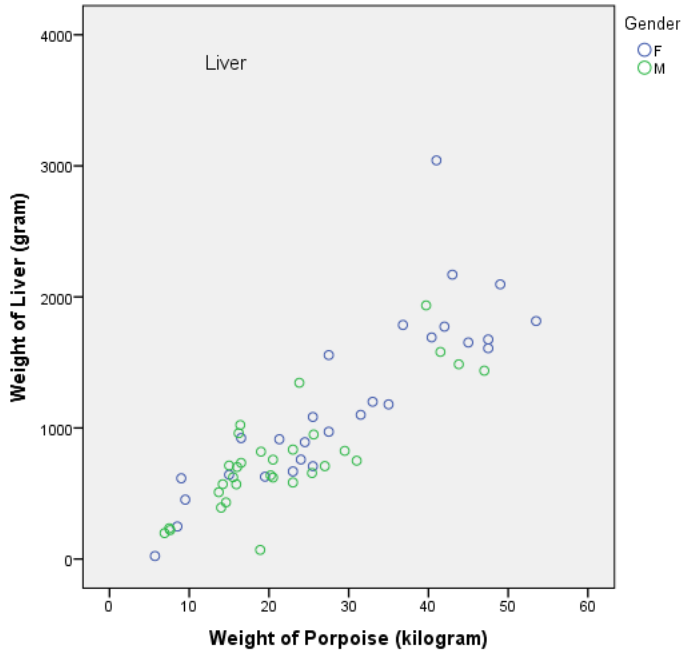

Figure 3: Weight of Liver (gram) relative to the body weight (kilogram) of 59 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

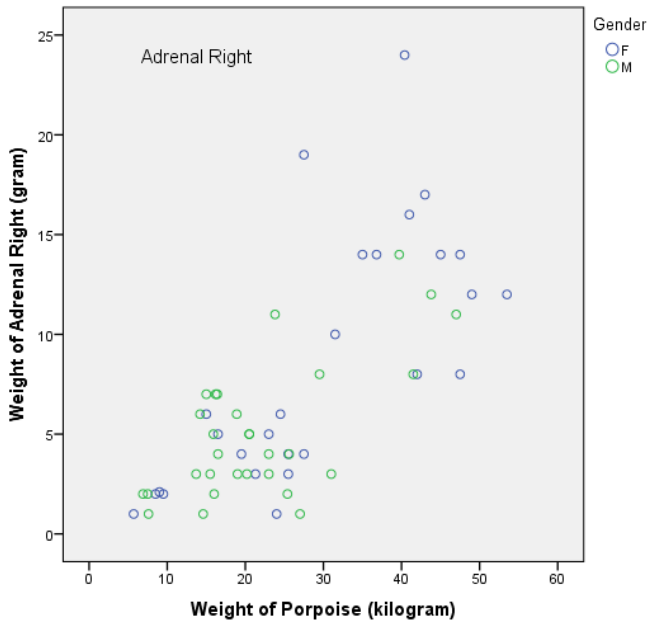

Figure 4: Weight of Adrenal Right (gram) relative to the body weight (kilogram) of 58 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

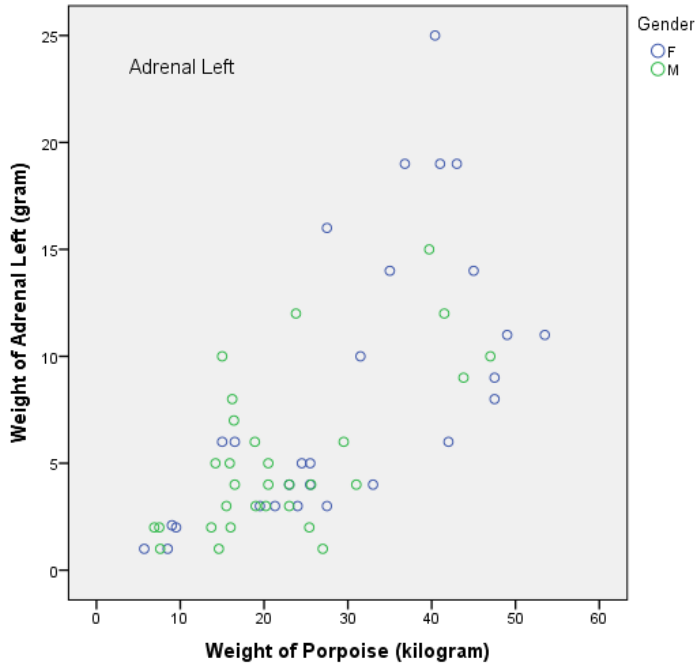

Figure 5: Weight of Adrenal Left (gram) relative to the body weight (kilogram) of 59 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

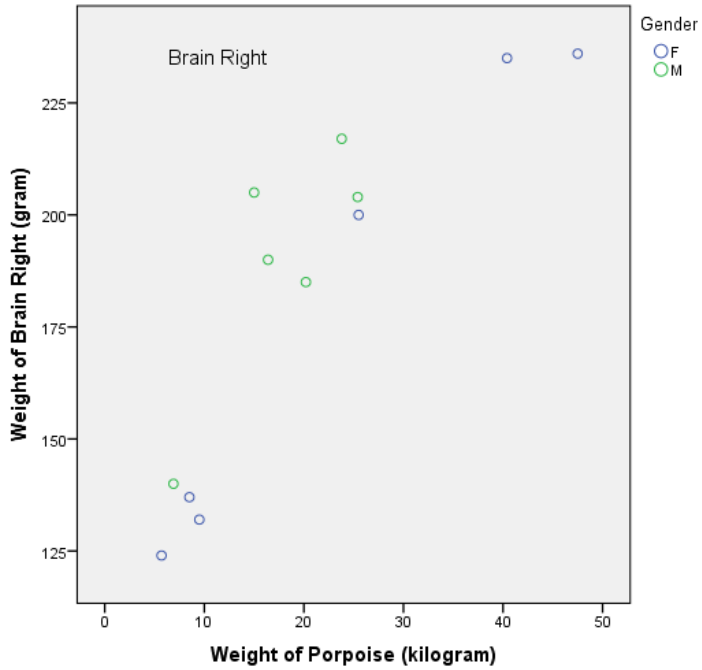

Figure 6: Weight of Brain Right (gram) relative to the body weight (kilogram) of 12 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

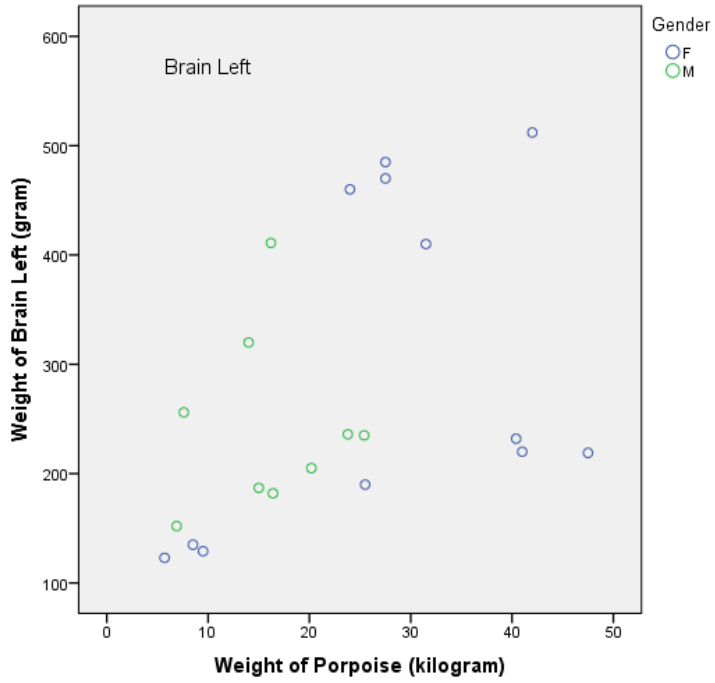

Figure 7: Weight of Brain Left (gram) relative to the body weight (kilogram) of 21 stranded porpoises. This scatterplot shows a moderate dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

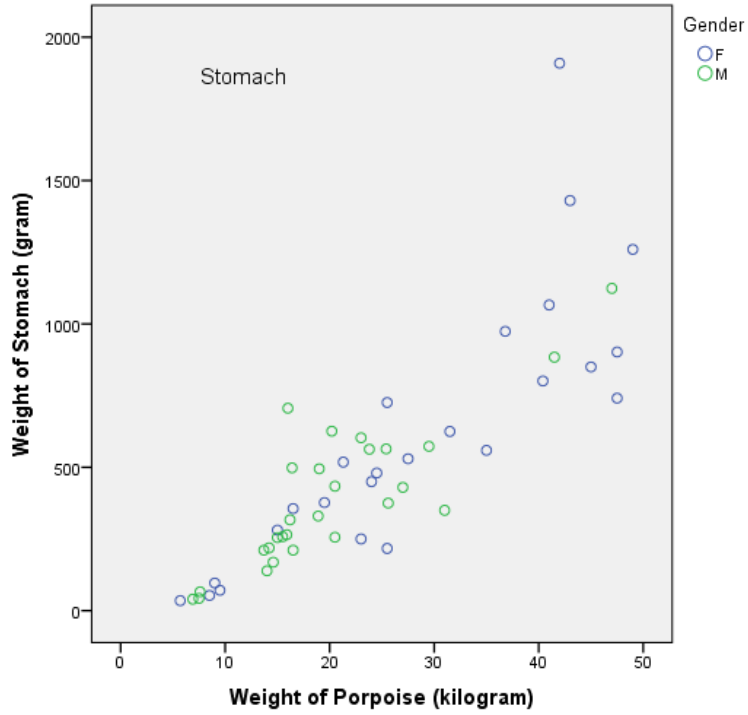

Figure 8: Weight of Stomach (gram) relative to the body weight (kilogram) of 53 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

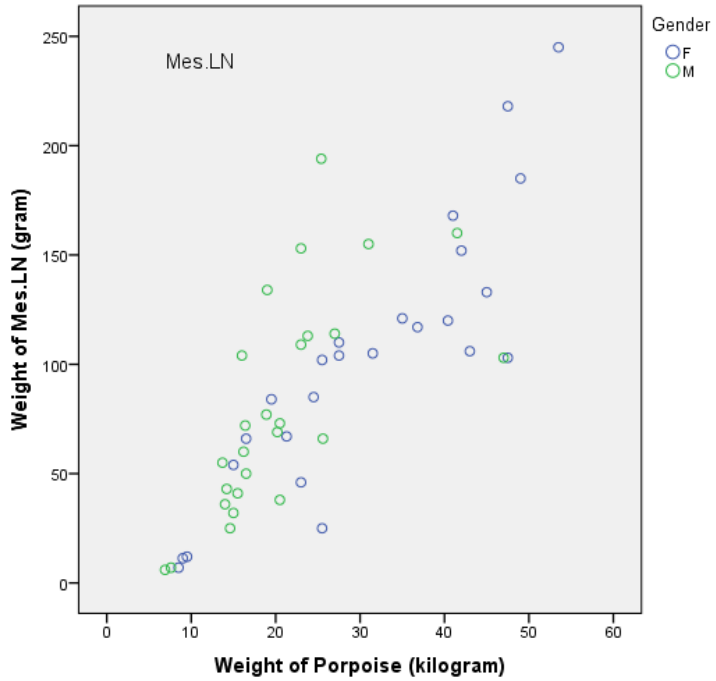

Figure 9: Weight of Mes.LN (gram) relative to the body weight (kilogram) of 51 stranded porpoises. This scatterplot shows a dense cloud of points The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

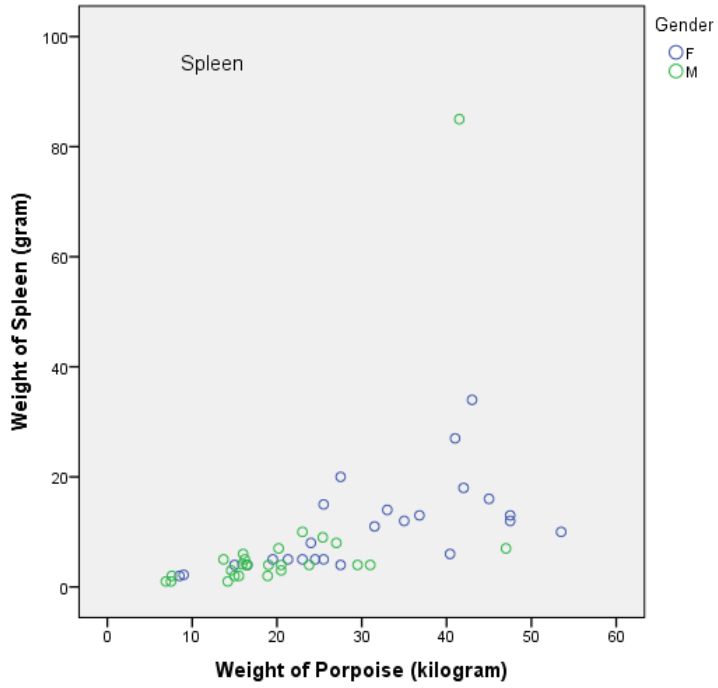

Figure 10: Weight of Spleen (gram) relative to the body weight (kilogram) of 51 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

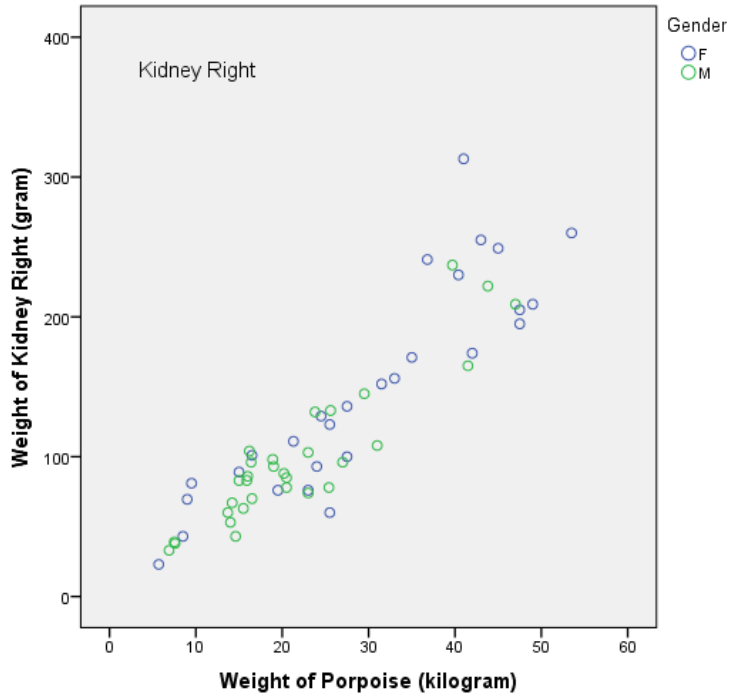

Figure 11: Weight of Kidney Right (gram) relative to the body weight (kilogram) of 59 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

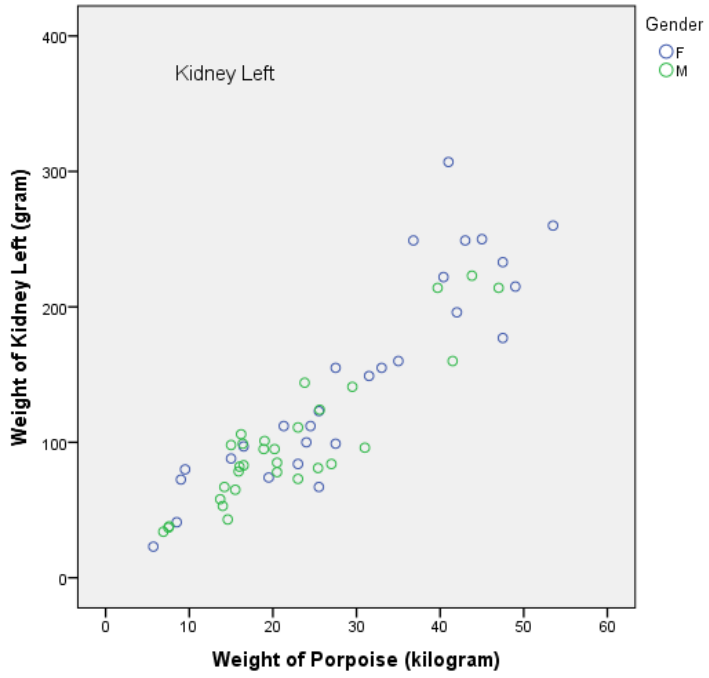

Figure 12: Weight of Kidney Left (gram) relative to the body weight (kilogram) of 59 stranded porpoises. This scatterplot shows a dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

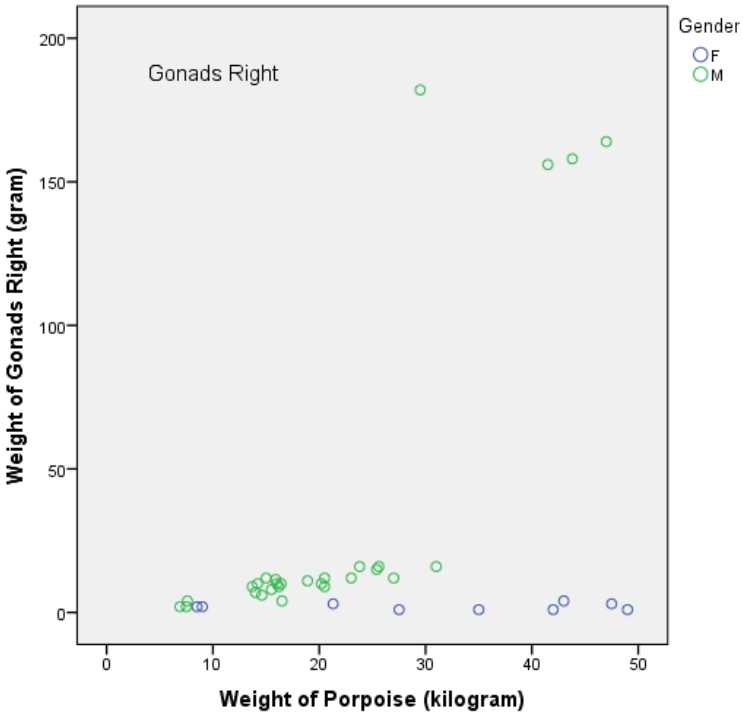

Figure 13: Weight of Gonads Right (gram) relative to the body weight (kilogram) of 38 stranded porpoises. This scatterplot shows a moderate dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.

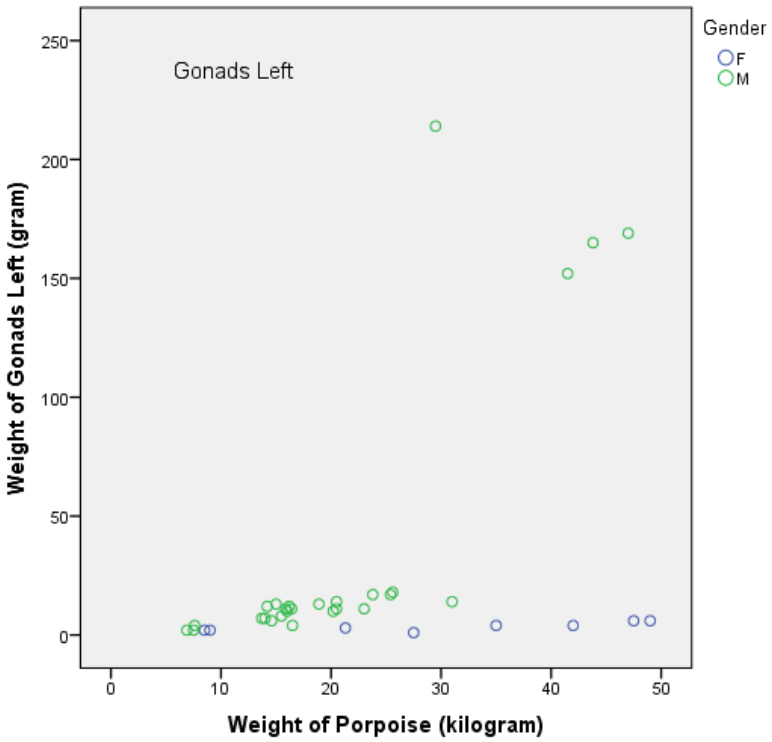

Figure 14: Weight of Gonads Left (gram) relative to the body weight (kilogram) of 37 stranded porpoises. This scatterplot shows a moderate dense cloud of points. The data is from an investigation of "Postmortaal onderzoek van bruinvissen uit Nederlandse wateren 2009 – 2013" of the Utrecht University.