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(51) Int.Cl.⁶ G06F 19/00, G06F 17/40

(30) 1998/03/24 (09/047,088) US

(54) **METHODE ET SYSTEME POUR LA SURVEILLANCE DES ANIMAUX**

(54) METHOD AND SYSTEM FOR MONITORING ANIMALS

<u>Animal Health</u>	
<u>Animal</u>	<u>Days on Feed</u>
A	40
B	65
C	135
D	10
•	•
•	•
•	•

<u>Zone Definition</u>	
Feedlot Pen A	
<u>Zone</u>	<u>XY Coordinates</u>
14	{Data Set}
16	{Data Set}
18	{Data Set}
20	{Data Set}
•	•
•	•
•	•

<u>Physical Condition Table</u>		
<u>Animal Health</u>		
	Respiratory Disorder	Reference Movement Pattern Data 1
	Gastrointestinal Disorder	Reference Movement Pattern Data 2
	.	.
	.	.
	.	.
<u>Performance Characteristics</u>		
	Yield Grade 1	Reference Movement Pattern Data 10
	Yield Grade 2	Reference Movement Pattern Data 11
	.	.
	.	.
	.	.
	Quality Grade Prime	Reference Movement Pattern Data 15
	.	.
	.	.
	.	.
<u>Production Characteristics</u>		
	Market Ready	Reference Movement Pattern Data 20
	.	.
	.	.
	.	.

(57) In a method and system for monitoring animals within an area, position data of each animal within the area is collected at intervals. The position data is then processed to generate movement pattern data of the animals. The movement pattern data is then analyzed to determine at least one physical condition of the animals. A method and system for tracking animals as they are prepared for slaughter is also provided.

ABSTRACT

In a method and system for monitoring animals within an area, position data of each animal within the area is collected at intervals. The position data is then
5 processed to generate movement pattern data of the animals. The movement pattern data is then analyzed to determine at least one physical condition of the animals. A method and system for tracking animals as they are prepared for slaughter is also provided.

METHOD AND SYSTEM FOR MONITORING ANIMALS

Field of the Invention

The present invention relates to tracking systems and in particular to a system and method for monitoring the movement of animals within an area to determine at least one physical condition of the animals. The present invention also
5 relates to a system and method for tracking livestock as they are prepared for slaughter.

Background of the Invention

As is well known, livestock are typically bred at ranches. From the
10 ranches the livestock may proceed to backgrounders for a period of time before being sent to feedlots for final preparation prior to slaughter by packers. The ranches, backgrounders, feedlots and packers are often geographically dispersed. At the feedlot, the livestock are processed in a hospital and processing area and treated with a variety of pharmaceuticals before being delivered to pens in the feedlot. In the feedlot
15 pens, the animals' rations are varied at specific times to prepare the animals for slaughter. During the animals' stay in the feedlot, the animals are examined regularly by sight to detect sick animals as well as animals that appear ready for market. This requires individuals to move through the feedlot pens on horseback resulting in the livestock being disrupted and their stress levels increased.

20 When an animal is determined to be market ready, the animal is shipped to the slaughterhouse. At the slaughterhouse, the quality of the animal is evaluated by the packer based on one of two government standards, namely yield grade or quality grade. Yield grade is a measure of an animal's red meat to fat and bone ratio. Yield grade 1, the most attractive, has a high red meat to fat and bone
25 ratio while yield grade 5, the least attractive, has a low red meat to fat and bone ratio. Quality grade is a measure of an animal's intra-muscular fat associated with quality. In the United States, the four quality grades are Prime, Choice, Select and Standard. In Canada, the four corresponding quality grades are Prime, AAA, AA and A.

Ideally, animals that are shipped to the slaughterhouses meet high
30 quality standards since penalties are imposed on feedlot operators for animals that do not meet quality standards. The tendency therefore, is for feedlot operators to put animals on feed for longer durations even though the animals may be considered

market ready. This poses problems in that feed costs and methane or greenhouse gas production are increased.

When an animal at a feedlot is identified as being "sick", the animal is physically captured and taken to a hospital where the animal's temperature is taken to
5 determine if in fact the animal is sick. Physically capturing the animal of course causes significant stress. If the animal is sick, the animal is treated with a range of antibiotics to cure many illnesses regardless of whether the animal requires treatment for all of these illnesses. If the animal is not sick, the animal is returned to the feedlot after having been stressed for no reason. Unfortunately, visual inspection of livestock
10 to determine sickness is subjective making the accuracy of this method questionable. Also, significant lengths of time may elapse before sick animals show visual symptoms. As will be appreciated, this prior art method of monitoring livestock in a feedlot suffers many disadvantages.

Systems to monitor animals remotely to collect data concerning the
15 condition of the animals are known. For example, U.S. Patent No. 5,474,085 to Humnik et al. discloses an apparatus for remote sensing of livestock using a thermographic imaging system. The thermographic imaging system remotely monitors the location, weight and temperature of livestock by taking thermographic images of the animals. The thermographic images are digitized and converted into
20 number arrays. The number arrays are interpreted by software executed by a computer to provide animal weight information in a decipherable form.

Canadian Patent No. 1,296,068 to Friesen discloses a physiological monitoring system to measure physiological functions such as the pulse rate or temperature of an animal. The system includes a remote telemetry system carried by
25 the animal including sensors to sense conditions of the animal and store data representing the sensed conditions. The stored data is then transmitted to a master telemetry system for processing.

In the article entitled "Feeding Behavior of Feedlot Cattle" authored by Sowell et al., a system to measure the feeding behavior of feedlot cattle by monitoring
30 cattle at a feedbunk is described. The system includes passive radio frequency (RF) tags carried by the cattle. A read panel in close proximity to the feedbunk communicates with the RF tags carried by cattle at the feedbunk to allow the presence

and location of the cattle at the feedbunk to be recorded. The recorded information is processed to determine the average time untreated and treated cattle spend at the feedbunk.

Although the above-identified references disclose systems to monitor
5 animals remotely, improved systems to provide information concerning the physical condition of animals within an area are desired.

It is therefore an object of the present invention to provide a novel method and system for monitoring animals within an area to determine at least one physical condition of the animals. It is also an object of the present invention to
10 provide a novel method and system for tracking livestock as they are prepared for slaughter.

Summary of the Invention

According to one aspect of the present invention there is provided a
15 method of monitoring the movement of animals within an area comprising the steps of:

collecting positional data of each animal under observation;
processing said positional data to generate data representing the
movement patterns of said animals; and

20 analyzing said movement pattern data to determine at least one physical condition of said animals.

In a preferred embodiment, the positional data is collected remotely and at intervals. During the analyzing step, the movement pattern data is compared with reference movement pattern data stored in a database representing typical
25 movement patterns of animals exhibiting the at least one physical condition. The movement pattern data is compared with the reference movement pattern data to detect animals suspected of suffering a health problem. In this regard it is preferred that the movement pattern data is compared with reference movement pattern data to detect animals exhibiting one or more of the following characteristics:

30 more frequent and longer duration visits to the water zone;
less frequent visits to the water zone;
generally overall decreased movement within the area;

more frequent and shorter duration visits to the water zone; and
less frequent and shorter duration visits to the water zone.

It is also preferred that the movement pattern data is compared with
reference movement pattern data to detect the frequency and duration animals spend
5 in the food zone either to determine a yield grade or quality grade for each animal.
Furthermore, it is preferred that the movement pattern data is compared with reference
movement pattern data to determine market ready animals. In this case, market ready
animals can be shipped to slaughterhouses more quickly and reductions in greenhouse
gas production can be calculated and sold as offsets to greenhouse gas producers.

10 According to another aspect of the present invention there is provided a
system for monitoring the movement of animals within an area comprising:

a plurality of data collection and transmission units, each being carried
by a respective animal, each of said data collection and transmission units transmitting
animal position data over a wireless communications link; and

15 a processor in communication with said data collection and
transmission units via said wireless communication link and receiving said animal
position data, said processor processing said animal position data to generate data
representing movement patterns of said animals and analyzing said movement pattern
data to determine at least one physical condition of said animal.

20 According to another aspect of the present invention there is provided a
system for detecting animals exhibiting at least one physical condition of interest
within a predefined area comprising:

a receiver receiving position data for each of said animals under
observation at intervals;

25 a processor in communication with said receiver and processing said
position data to generate a first database including data representing the movement
pattern of each of said animals within said predefined area; and

a second database storing reference movement pattern data
representing typical movement patterns of animals having physical conditions of
30 interest, wherein said processor compares said movement pattern data in said first
database with said reference movement pattern data in said second database to
determine animals exhibiting one or more physical conditions of interest.

According to another aspect of the present invention there is provided a program product comprising:

a computer-readable storage medium:

means recorded on the medium for processing animal position data to
5 generate data representing the movement patterns of animals; and

means recorded on the medium to compare the movement pattern data with reference movement pattern data to determine at least one physical condition of said animals.

According to still yet another aspect of the present invention there is
10 provided a method for tracking the movement of animals as said animals are moved from location to location during processing comprising the steps of:

tagging each animal under observation; and

tracking the location of each tagged animal and the duration each
tagged animal spends at each location as it is moved to generate data representing
15 each tagged animal's movement history.

Preferably, the generated data represents each tagged animal's movement history generally over its lifespan. It is also preferred that the locations include ranches, backgrounders, feedlots and packers.

In one embodiment, the generated data is used to detect tagged animals
20 that have been in physical proximity with a tagged animal diagnosed with a transmittable disease. In another embodiment, the generated data is used to detect locations that may be the cause of a trend exhibited by specific tagged animals.

According to still yet another aspect of the present invention there is provided a system for tracking the movement of tagged animals as said animals are
25 moved from location to location during processing comprising:

at each location, a reader to read the tag on each of said animals thereat; and

a processor in communication with said reader, said processor storing a record of each tagged animal's duration at said location.

30 The present invention provides advantages in that by tracking the movement of each animal within the area, sick animals can be identified and treated quickly. Not only can sick animals be identified but based on their movement

patterns, the cause of sickness can be better diagnosed reducing the overall amounts of antibiotics used to treat sick animals.

In the case of animals within a feedlot, the yield or quality grade of the animals can be determined during their stay at the feedlot allowing animals to be
5 grouped according to grade and their feed composition and rations adjusted accordingly to increase performance. In addition, by tracking the movement pattern of each animal, changes in the feeding patterns of the animals can also be detected allowing market ready animals to be determined quickly. This allows feedlot operators to ship animals to slaughterhouses faster without compromising
10 performance resulting in reduced feed costs, a reduction in the production of greenhouse gasses by the animals and fewer animals gaining too much fat and weight. Furthermore, by monitoring the movement patterns of the animals, overfeeding and underfeeding conditions in the feedlot can also be determined allowing the feedlot operators to take appropriate action.

15 In other environments such as pastures and grazing pens, by monitoring the movement patterns of the animals, low food levels, poor water quality and heavy grazed areas can be determined. Also, animals in heat and those likely suffering a reproductive disorder can be determined. This allows corrective measures to be taken to improve the condition of the animals.

20 In addition, by tracking the livestock as they are prepared for slaughter data representing the livestock's movement history are generated. The data can be used to determine animals, which were in physical proximity of a diagnosed diseased animal thereby limiting the focus of animal testing. The data can also be used to determine locations, which may be the cause of trends exhibited by specific animals.

25

Brief Description of the Drawings

Embodiments of the present invention will now be described more fully with reference to the accompanying drawings in which:

30 Figure 1 is a diagram of a feedlot including a plurality of feedlot pens divided into a plurality of zones;

Figure 2 is a block diagram of a system for feedlot management in accordance with the present invention;

Figure 3 is a block diagram of a data collection and transmission unit forming part of the system for feedlot management of Figure 2;

Figure 4 is a flowchart illustrating data processing in the system for feedlot management of Figure 2;

5 Figures 5a and 5b illustrate tables used in the system for feedlot management of Figure 2;

Figure 5c illustrates a virtual table created by the system for feedlot management during processing of data;

10 Figure 6 is an alternative embodiment of a system for feedlot management in accordance with the present invention;

Figures 7a to 7d are graphs illustrating the frequency/duration of animals feeding vs. a number of different characteristics of interest; and

Figure 8 is a table showing ranchers, backgrounders, feedlots and packers at geographically dispersed locations.

15

Detailed Description of the Preferred Embodiments

In general, the present invention relates to a system and method for monitoring the movement of animals within an area to determine at least one physical condition of the animals. The present inventors have found that the movement
20 patterns of animals provide a wealth of information concerning their physical conditions including but not limited to animal health; performance characteristics such as yield grade, quality grade, back fat percentage, weight etc.; and production patterns such as market readiness, insufficient feeding, overfeeding, greenhouse gas emissions etc. During monitoring of the animals, data concerning the movement of
25 each animal within a defined area is collected at intervals, processed and stored. Physical condition definitions including reference movement pattern data representing typical movement patterns of animals having specific characteristics, traits, behaviors, and/or conditions etc. (hereinafter collectively referred to as "conditions") of interest, are also stored. The collected animal movement data is compared with the reference
30 movement pattern data to allow animals to be classified according to these specific conditions of interest. This allows unhealthy animals to be detected quickly and treated and animals exhibiting other specific conditions of interest to be grouped. A

preferred embodiment of the present invention will now be described more fully wherein the system and method are used to monitor the movement of animals, such as cattle, in a feedlot.

The present invention also relates to a method and system for tracking
5 livestock generally throughout their lifespan as they are prepared for slaughter. As mentioned previously, most livestock are moved between geographically dispersed locations as they move from ranchers, backgrounders, feeders and finally to packers. The present inventors have found that by monitoring animals from the ranches to the packers, if an animal is determined to be sick, the testing of other animals can be
10 limited to those animals that were in physical proximity to the sick animal. As a result, the scope of required testing can be significantly narrowed.

Referring now to Figure 1, a feedlot is shown and is generally indicated to by reference numeral 10. As can be seen, the feedlot 10 includes a plurality of feedlot pens 12, each of which accommodates a plurality of animals (not
15 shown). Each feedlot pen 12 is divided into a number of zones, namely a food zone 14, a water zone 16, a bedding zone 18 and an activity zone 20. Animals are free to move in the feedlot pens 12 between the various zones 14 to 20. A hospital and processing area 22 is also provided to treat sick animals removed from the feedlot pens 12 and to treat new animals entering the feedlot 10. In the present feedlot 10, the
20 movement of each animal in its respective feedlot pen 12 is monitored and corresponding data is collected at intervals, processed and stored. In this manner, the number of times and duration each animal visits the various zones 14 to 20 within its feedlot pen 12 can be determined.

In order to monitor the movement of the animals in each feedlot pen
25 12, each animal is fitted with a collar or tag (not shown) to which a data collection and transmission unit 32 is attached (see Figures 2 and 3). The data collection and transmission unit 32 on the tag fitted to each animal is unique to that animal and stays with the animal during its entire stay in the feedlot 10. The data collection and transmission units 32 collect raw GPS data representing their positions from orbiting
30 GPS satellites 33. The raw GPS data is accurate to about 100m.

Turning now to Figure 3, one of the data collection and transmission units 32 is better illustrated. As can be seen, the data collection and transmission unit

32 includes a global positioning system (GPS) receiver 34 connected to an external antenna 36 and to a microcontroller 38 having resident memory. The microcontroller 38 is also connected to a radio frequency spread spectrum (RFID) engine 40 having an antenna 42. A power supply 44 is connected to the GPS receiver 34, microcontroller 5 38 and RFID engine 40.

Communicating with data collection and transmission units 32 on animal tags carried by animals in a plurality of feedlot pens 12, at user selected intervals, is an interrogator 50. The interrogator 50 also communicates with a data collection and transmission unit at a fixed location (not shown) to provide a field 10 reference allowing GPS satellite signal propagation errors to be determined. A first processor 52 in the form of a Pentium® personal computer (PC) is connected to the interrogator 50. The processor 52 receives the raw GPS data from the interrogator 50 and processes the raw GPS data to sub-metre accuracy. Thereafter the processor 52 converts the GPS data into XY coordinates and stores the XY coordinates in an 15 animal observation table together with other relevant information as will be described.

A second processor 54, also in the form of a personal computer, is connected to the processor 52 via a local area or wide area network. The processor 54 receives the animal observation table from processor 52 at intervals. The processor 54 executes software to process the data in the animal observation table to allow animals 20 to be classified according to specific conditions of interest as will be described. Although not shown, the processor 54 includes a graphical user interface (GUI) to allow the results of the classifications to be visually presented and manipulated as desired.

Stored within the processor 54 are a plurality of tables (best seen in 25 Figure 5a), namely a zone definition table, an animal health table and a physical condition table. The zone definition table includes data defining the zones of each feedlot pen 12 in XY coordinates. The data in the zone definition table can be edited as desired allowing the zones in the feedlot pens 12 to be reconfigured. The animal health table includes data indicating the number of days each animal has been on feed 30 since the arrival of the animal at the feedlot 10. The physical condition table stores a plurality of definitions. Each definition includes reference movement pattern data representing the typical movement pattern of an animal exhibiting a specific physical

condition of interest to which the animals under observation are to be compared. The physical condition table can be edited to add or remove definitions. Also, the reference movement pattern data for each definition can be edited to update the definitions when new data becomes available.

5 In the present embodiment, the physical condition definitions relate to animal health, performance characteristics, and production patterns including greenhouse gas emissions. The physical condition definitions relating to animal health include reference movement pattern data modeling the typical movement patterns of animals suffering respiratory, gastrointestinal and neurological disorders
10 and exhibiting muscular skeletal injuries.

 The physical condition definitions relating to performance characteristics include reference movement pattern data modeling the typical movement patterns of animals of different yield grades, different quality grades, different back fat percentages, and different weights as a function of days on feed.

15 The physical condition definitions relating to production patterns include reference movement pattern data modeling the typical movement patterns of animals that are market ready, overfed and underfed. The definitions in the physical condition table will now be described more fully.

20 Animal Health

 Referring now to Table 2, the typical movement patterns of animals suffering from different health problems are set out. It has been determined that animals spending more time at the water zone and visiting the water zone more often while spending less time in the food zone and generally being overall less active are
25 likely to be suffering one of several respiratory diseases. Reference movement pattern data modeling this movement pattern is stored as a definition in the physical condition table to allow animals exhibiting this movement pattern to be identified quickly. In this manner, early identification of animals suffering respiratory diseases can be achieved allowing animals to be treated in the hospital and processing area 22 quickly
30 and returned to the feedlot 10.

 It has also been determined that animals moving very little are likely to be suffering a muscular skeletal injury. Reference movement pattern data modeling

this movement pattern is stored as a definition in the physical condition table to allow animals exhibiting this movement pattern to be identified quickly. In this manner, early identification of animals suffering muscular skeletal injuries can be achieved allowing animals to be treated quickly in the hospital and processing area 22 and
5 returned to the feedlot 10. In addition, it has been determined that stationary animals or animals moving in a circle in one direction likely suffer neurological disorders. Reference movement pattern data modeling these movement patterns is stored as definitions in the physical condition table to allow animals exhibiting these movement patterns to be identified quickly. In this case, the animals can be shipped from the
10 feedlot 10 early to reduce production costs.

It has also been determined that animals visiting the water zone often and for short durations or visiting the water zone infrequently and for short durations are likely to be suffering gastrointestinal disorders. Reference movement pattern data modeling these movement patterns is stored as definitions in the physical condition
15 table to allow animals exhibiting these movement patterns to be identified quickly. Early detection of animals suffering gastrointestinal disorders can prevent animal death through treatment at the hospital and processing area 22.

Performance Characteristics

20 With respect to performance characteristics, it has been determined that yield grade and quality grade of cattle can be correlated to the frequency and duration cattle spend in the food zone of the feedlot pen 12. Referring now to Figure 7a, a graph showing the frequency and duration cattle of different yield grades spend feeding over an eight week period is illustrated. As can be seen, cattle having a yield
25 grade 1 consistently spend more time in the food zone and visit the food zone more often than cattle of other yield grades. Accordingly, cattle showing a pattern of higher frequency visits and longer duration visits in the food zone relative to other animals will have a better yield grade. Reference movement pattern data modeling the graphical data is stored as definitions in the physical condition table to allow animals
30 to be classified according to yield grade and grouped if desired.

Figure 7b shows a graph of the frequency and duration cattle of different quality grades spend in the food zone over an eight-week period. As can be

seen, cattle having a high quality grade consistently spend less time in the food zone and visit the food zone less often than cattle of other quality grades. Reference movement pattern data modeling the graphical data is stored as definitions in the physical condition table to allow animals to be classified according to quality grade and grouped if desired.

Figure 7c shows a graph of the frequency and duration cattle having different amounts of back fat spend in the food zone over an eight-week period. As can be seen, cattle having less back fat consistently spend more time in the food zone and visit the food zone more often than cattle having more back fat. This is important since the amount of back fat carried by the animal will effect its yield grade. Reference movement pattern data modeling the graphical data is stored as definitions in the physical condition table to allow animals to be classified according to back fat percentage and grouped if desired.

Figure 7d shows a graph of the frequency and duration cattle of different weight groups spend in the food zone over an eight-week period. As can be seen, cattle classified as "heavy" consistently spend less time in the food zone and visit the food zone less often than normal weight cattle. This is important since heavy animals are frequently discounted due to the fact that they are over fat and do not meet size and handling standards at slaughterhouses. Reference movement pattern data modeling the graphical data is stored as definitions in the physical condition table to allow animals to be classified according to weight and grouped if desired.

Production Patterns

With respect to production characteristics, animals spending less time in the food zone and visiting the food zone less nearing the end of their stay in the feedlot, can be identified as being market ready. This characteristic can be clearly seen in the graphs of Figures 7a and 7b. Reference movement pattern data modeling this movement pattern is stored as a definition in the physical condition table to allow animals showing this movement pattern to be identified quickly. Identified market ready animals can be shipped to slaughterhouses in a more timely manner. This maintains high performance standards in the feedlot by inhibiting animals from remaining in the feedlot too long. Animals remaining in the feedlot 10 while on feed

too long tend to gain extra skeletal fat, which of course reduces performance. In addition, lengthening the stay of animals in the feedlot while on feed increases greenhouse gas emissions.

Definitions including reference movement pattern data modeling
5 animal movement patterns where most animals move to the food zone when the feed truck passes or when few animals move to the food zone when the feed truck passes are also stored in the physical definition table. In the former case, insufficient feeding of animals having high energy requirements can be detected quickly and their feed rations adjusted accordingly. In the later case, overfeeding of animals can be detected
10 quickly and their feed rations adjusted according to lower feed costs.

Referring now to Figure 5b, some of the physical condition definitions are better illustrated. As can be seen, the reference movement pattern data includes threshold levels against which the movement patterns of the animals are compared. For example, in the case of the physical condition definition relating to respiratory
15 disorders, the reference movement pattern data includes threshold levels to indicate high frequency and long duration visits to the water zone, low frequency and short duration visits to the food zone as well as overall low activity. The physical condition definition relating to gastrointestinal disorders has reference movement pattern data including threshold levels to indicate high frequency and short duration visits to the
20 water zone and low frequency and short visits to the food zone.

The physical condition definition relating to yield grade 1 at a specific stage determined by days on feed has reference movement pattern data including threshold levels to indicate high frequency and long duration visits to the food zone as well as days on feed. The physical condition definition relating to market ready
25 animals has reference movement pattern data including threshold levels to indicate medium frequency and medium duration visits to the food zone as well as days on feed. Animal movement pattern data is compared with these threshold levels to determine if the movement patterns of the animals meet the definitions.

The operation of the present method and system for monitoring
30 animals will now be described.

When animals arrive in the feedlot in preparation for slaughter, the animals proceed through the feedlot 10 in stages. Typically, animals proceed through

the feedlot in three stages, namely an early stage, a growth stage and a finish stage. Table 1, shows the time, ration, health protocol and animal movement patterns of interest during each stage. To improve performance of the feedlot, it is desired to identify and treat sick animals quickly, to classify animals according to one or more performance characteristics so that feed composition and rations can be adjusted accordingly, and to monitor production patterns so that market ready animals and undesired feedlot conditions can be detected quickly. The method and system according to the present invention provides for the above.

At selected intervals, in this case approximately every 15 seconds, the GPS receiver 34 in each data collection and transmission unit 32 is conditioned by the microcontroller 38 to poll the GPS satellites 33 and collect raw GPS data representing the associated animal's position within the feedlot pen 12 (see block 100 in Figure 4). The raw GPS data is then conveyed to the microcontroller 38. When the microcontroller 38 receives the raw GPS data, it stores the raw GPS data in its resident memory together with a time stamp.

The interrogator 50 is programmed to poll the data collection and transmission units 32 in a predetermined sequence to read the raw GPS data and time stamps stored therein at intervals. Specifically, the interrogator 50 continuously cycles through each data collection and transmission unit 32 in numerical order. If a data collection and transmission unit 32 cannot be read due to a lack of a clean line of sight, the interrogator 50 skips that data collection and transmission unit 32 and attempts to read it during the next cycle.

When a data collection and transmission unit is being read by the interrogator 50, the interrogator 50 sends an addressed command to that data collection and transmission unit 32 by way of a wireless RF communications link. When the RFID engine 40 in the data collection and transmission unit 32 receives the command, the command is passed to the microcontroller 38. Upon receiving the command, the microcontroller 38 responds to the command by sending the raw GPS data and time stamp stored in its resident memory to the RFID engine 40. The RFID engine 40 in turn transmits the raw GPS data and time stamp together with an identifier to the interrogator 50 via the wireless RF communications link. When the

-15-

interrogator 50 receives the transmitted data from the data collection and transmission unit 32, it conveys the data to the processor 52.

When the processor 52 receives the raw GPS data, time stamp and identifier from one of the data collection and transmission units 32, the received data is processed using GrafNav software by Waypoint Consulting to increase the accuracy of the GPS data and is placed as an entry into the animal observation table (block 102). The time stamp is synchronized to GPS time and is adjusted for local time. The animal observation table in the present embodiment is in the form of an SQL database. Each entry made in the SQL database takes the form:

10 ("Tag Number", "X", "Y", "Time")

where:

"Tag Number" is the data collection and transmission unit identifier;

"X" and "Y" represent the animal position either in latitude and longitude or in co-ordinates referenced to a survey point; and

15 "Time" is the microcontroller time stamp.

Since the interrogator 50 continuously cycles through the data collection and transmission units 32, the SQL database is continuously updated at intervals to provide current and historical positional data concerning each of the animals in the feedlot pens 12. In this manner, a record of each animal's movement pattern within the feedlot pen 12 is maintained.

The processor 52, which communicates with the processor 54, downloads the SQL database to the processor 54 at predetermined intervals so that animal movement pattern data over a fixed time period is received by the processor 54. Once the SQL database has been downloaded, the processor 54 executes a routine and using the SQL database and the zone definition table creates a virtual table including the animal observation table entries together with current and previous zone position information (block 104). The entries in this virtual table take the form:

("Tag Number", "X", "Y", "Time", "Zone In", "Zone From")

where:

30 "Zone In" represents the current zone position of the animal; and

"Zone From" indicates whether the animal has moved from one zone to another between successive entries in the table.

Figure 5c illustrates an example of the virtual table for a single animal identified as "A". As can be seen, the Zone In and Zone From entries indicate the general movement pattern of animal A in the feedlot pen 12 over a period of time. The X and Y coordinate data entries provide detailed movement pattern data
5 concerning animal A over the same period of time.

Once this virtual table is created, the processor 54 executes another routine to compare the virtual table with the physical condition definitions to determine whether the animals exhibit any of the physical conditions of interest as defined by the reference movement pattern data. The reference movement pattern
10 data function as benchmarks against which the animals under observation can be compared. By comparing the virtual table contents with the physical condition definitions, animal health and performance characteristics decisions can be made (block 106).

For example, when the virtual table of Figure 5c is being compared
15 with the respiratory disorder definition in the physical condition table, the processor 54 determines:

the frequency animal A visited the water zone using the Zone In, Zone From and Time entries;

the duration animal A spent in the water zone using the Zone In and
20 Time entries;

the frequency animal A visited the food zone using the Zone In, Zone From and Time entries;

the duration animal A spent in the food zone using the Zone In and Time entries; and

25 the general overall activity of the animals using the X and Y coordinate data entries.

The calculated values are then compared with the threshold levels in the definition. If the animal meets all of the conditions of the definition, the animal is considered to be suffering a respiratory disorder.

30 The above process is performed in respect of the animal movement data collected for each of the animals in the feedlot and a comparison between the animal movement data and each of the definitions in the physical condition table is

made. The results of the comparisons are displayed via the GUI allowing feedlot owners to identify sick animals, classify other animals according to performance characteristics and take measures to deal with identified production patterns. Animals identified as being sick are generally presented in a list according to disorder. With
5 respect to animals classified according to performance characteristics, the animals can be presented in a list or alternatively the movement patterns of the animals can be presented graphically. With respect to animals classified according to performance characteristics, market ready animals are generally presented in a list, while overfeeding and underfeeding conditions are presented as display screens to the
10 feedlot operator.

In addition to the above, since the movement patterns of the animals in the feedlot 10 are monitored, changes in the overall feeding patterns of the animals can be detected. It is known that the feeding patterns of animals change at each stage in the feedlot as illustrated in Table 1. By detecting changes in feed patterns of
15 animals quickly, operators can apply appropriate protocols for specific animals at appropriate times to optimize processing of the animals through the feedlot. This allows feedlot operators to determine the proper time to implant hormones. This also allows an operator to control the composition and/or amount of feed supplied to the animals which has a three-fold beneficial effect. Firstly, by controlling the
20 composition and/or amount of feed supplied to the animals, feed costs can be reduced. Secondly, in the case of high grade animals, feed can be controlled to inhibit the animals from gaining too much fat and weight which results in penalties for over fat/over large livestock. Lastly, by reducing the number of days the animals are placed on feed and/or by customizing the animals' diet, the animals produce less
25 methane thereby reducing production of greenhouse gases. Although reducing greenhouse gasses has an environmental benefit, another advantage exists. Greenhouse gas reductions can be sold as offsets to entities producing significant quantities of greenhouse gasses to allow these entities to meet greenhouse gas emission levels. This is achieved by determining the difference in time market ready
30 animals spend in the feedlot with the average industry time an animal spends in a feedlot and estimating the amount of methane gas those animals would have produced over that difference in time.

-18-

As one of skill in the art will appreciate, based on the results of animal movement patterns, sick animals can be quickly detected and treated for health problems. Animals showing other similar conditions can be detected and grouped and decisions can be made concerning the optimization of production. After animals
5 under observation have been slaughtered, carcass data can be obtained from the packer and reviewed relative to the definitions to allow the definition reference movement pattern data to be updated. Once the reference movement pattern data has been updated, the current and historical animal movement pattern data can be re-processed in the manner described above using the updated definitions thereby
10 enhancing the accuracy of the present method and system.

In the present embodiment, it is preferred that each animal is fitted with a collar or tag when born. It is also preferred that each rancher, backgrounder and packer includes an interrogator, processor and fixed data collection and transmission unit so that each animal's whereabouts in and duration at a ranch,
15 backgrounder and packer can be tracked. The position data for each animal is collected from the processors at the ranchers, backgrounders, feedlots and packers and is stored in a database. As mentioned previously, the ranchers, backgrounders, feedlots and packers are often at geographically dispersed locations. Figure 8 shows an example of rancher, backgrounder, feedlot and packer locations.

20 Tracking an animal generally throughout its lifespan as it is moved from location to location during processing is important especially if the animal is diagnosed with a transmittable disease. Since the animal's previous whereabouts are accurately maintained, the scope of testing to determine other infected animals can be limited to those places where the animal was located and not industry wide.

25 For example, suppose animal A is diagnosed with a transmittable disease by packer P3. By examining the database, it can be determined that:

the animal was born at ranch R1 and lived there from 98-03-01 to 98-09-30;

30 the animal was moved to backgrounder B2 and stayed there from 98-10-01 to 99-05-01;

the animal was then moved to feedlot F3 and stayed there from 99-05-02 to 99-11-30; and

the animal was moved to packer P3 on 99-12-01 where it was diagnosed.

Since the animal was diagnosed with a transmittable disease, animals in close proximity to the diseased animals are likely to have contracted the disease.

5 Using the above movement pattern of the animal, all animals that were exposed to the diagnosed animal can be located. Depending on the nature of the disease, the focus of testing can of course vary. For example, if the disease contracted by the animal is one which is normally contracted at a specific age such as 6 months, testing can focus on animals which were exposed to the diseased animal at ranch R1. If the disease is
10 contagious through the animal's life, testing must focus on animals, which were exposed to the diseased animals at ranch R1, backgrounder B2 and feedlot F3.

In addition, by monitoring each animal's movement, other trends can be identified and pinpointed to specific ranchers, backgrounders and feedlots. For example, it might be determined that animals born at a particular ranch or prepared at
15 particular backgrounders and feedlots exhibit a trend in terms of grade or other characteristic of interest.

Although the present invention has been described as including data collection and transmission units communicating with GPS satellites to generate raw GPS data, those of skill in the art will appreciate that alternative methods for
20 generating position data can be used. For example, as is shown in Figure 6, three GPS timing devices 134 can be positioned at various locations in the feedlot 10 with each GPS timing device communicating with RFID animal tags 132 carried by the animals that include data collection and transmission units 32. In this case, raw GPS data is acquired by each GPS timing device. Each GPS timing device 134 in turn sends the
25 raw GPS data to the data collection and transmission units on the RFID animal tags. The data collection and transmission unit in each RFID animal tag records the raw GPS data together with time stamps. When a data collection and transmission unit is polled by the interrogator 150, the data collection and transmission unit sends the raw GPS data and time stamps to the interrogator 150. The interrogator 150 in turn passes
30 the information to the processor 152 which enhances the accuracy of the GPS data and then calculates the XY coordinates of the data collection and transmission unit 32 by

triangulation. The data is then downloaded to the processor 154 and processed in the manner described previously.

Alternatively, the animals may be fitted with passive RFID animal tags or bar code tags. In the case of passive RFID animal tags, readers to detect and read the tags to record the animals' locations are required. Similarly, in the case of bar code tags, bar code readers to read the bar codes tags to record the animals' locations are required. These types of tags are more suited to environments where it is simply desired to determine each animal's general location and duration at the location such as at ranches, backgrounders and packers.

Although the system and method for monitoring animal movement patterns within an area have been described specifically with reference to a feedlot environment, those of skill in the art will appreciate that the movement patterns of animals can be monitored in other environments, such as for example in pastures or grazing pens. In this case, the movement patterns of animals can be monitored to determine if the animals suffer from any of the above noted health problems. In addition to the above, definitions including reference movement pattern data modeling the typical movement patterns of animals exhibiting conditions of interest in this environment can be stored in the physical condition table (see Table 2). Typical movement patterns of interest in this environment include but are not limited to:

- the movement of animals to a calving zone at inappropriate times indicating the likelihood of reproductive disorders;
- the grouping of female animals indicating animals in heat;
- the movement of animals along the perimeter of the grazing pen or pasture indicating low food levels; and
- the grouping of animals at the water zone for long durations indicating poor water quality.

In addition to the above, by monitoring the movement patterns of animals in the pasture or grazing pen, heavily used grazing areas can be determined allowing measures to be taken to increase feed in those areas or to move animals to other feeding areas.

The software executed by the processor 54 including the table of Figure 5b can be downloaded to the processor from a remote location over a network

link or can be stored on a physical medium such as a floppy disk or CD-ROM and then loaded onto the processor 54. This allows the software to be supplied to parties having their own animal tracking hardware.

Although particular embodiments of the present invention have been
5 described, those of skill in the art will appreciate that variations and modifications may be made without departing from the spirit and scope thereof as defined by the appended claims.

We Claim:

1. A method of monitoring the movement of animals within an area comprising the steps of:
 - 5 collecting positional data of each animal under observation;
 - processing said positional data to generate data representing the movement patterns of said animals; and
 - analyzing said movement pattern data to determine at least one physical condition of said animals.
- 10 2. The method of claim 1 wherein said positional data is collected at intervals.
- 15 3. The method of claim 1 or 2 wherein during said analyzing step said movement pattern data is compared with reference movement pattern data stored in a database representing typical movement patterns of animals exhibiting said at least one physical condition.
- 20 4. The method of claim 3 wherein said movement pattern data is compared with said reference movement pattern data to detect animals suspected of suffering a health problem.
- 25 5. The method of claim 4 wherein said movement pattern data is compared with said reference movement pattern data to detect generally stationary animals thereby to determine animals suspected of suffering a muscular skeletal injury and/or a neurological disorder.
- 30 6. The method of claim 4 wherein said movement pattern data is compared with said reference movement pattern data to detect animals circling in one direction thereby to determine animals suspected of suffering a neurological disorder.

7. The method of claim 4 wherein said area is divided into at least two zones including a food zone and a water zone and wherein said movement pattern data is compared with said reference movement pattern data to detect the duration and frequency said animals spend in at least one of said zones thereby to determine
5 animals exhibiting said at least one physical condition.

8. The method of claim 7 wherein said movement pattern data is compared with said reference movement pattern data to detect animals visiting said water zone more frequently and spending more time in said water zone at each visit
10 thereby to determine animals suspected of suffering a respiratory disorder.

9. The method of claim 8 wherein said movement pattern data is further compared with said reference movement pattern data to detect animals exhibiting generally overall decreased movement within said area.
15

10. The method of claim 7 wherein said movement pattern data is compared with said reference movement pattern data to detect animals visiting said water zone more frequently and spending less time in said water zone at each visit thereby to determine animals suspected of suffering a gastrointestinal disorder.
20

11. The method of claim 7 wherein said movement pattern data is compared with said reference movement pattern data to detect animals visiting said water zone less frequently and spending less time in said water zone at each visit thereby to determine animals suspected of suffering a gastrointestinal disorder.
25

12. The method of claim 7 wherein said movement pattern data is compared with said reference movement pattern data to detect animals exhibiting one or more of the following movement characteristics:

- (i) more frequent and longer duration visits to said water zone;
- 30 (ii) less frequent visits to said food zone;
- (iii) generally overall decreased movement within said area;
- (iv) more frequent and shorter duration visits to said water zone; and

- (v) less frequent and shorter duration visits to said water zone.

13. The method of claim 4 wherein said movement pattern data is compared with said reference movement pattern data to detect animals exhibiting one
5 or both of the following characteristics:

- (i) generally little movement within said area; and
- (ii) circling in one direction.

14. The method of claim 13 further comprising the step of removing
10 animals from said area which exhibit one or both of said characteristics.

15. The method of claim 3 wherein said area is divided into at least two zones, one of said zones being a food zone and wherein said movement pattern data is compared with said reference movement pattern data to detect movement of said
15 animals relative to said food zone.

16. The method of claim 15 wherein said movement pattern data is compared with said reference movement pattern data to detect the frequency and duration animals spend in said food zone.

20

17. The method of claim 16 wherein said movement pattern data is compared with said reference movement pattern data to determine a yield grade for each animal.

25 18. The method of claim 17 wherein said movement pattern data is compared with reference movement pattern data representing animals of optimal, standard and minimum yield grades to allow said animals under observation to be classified into optimum, standard and minimum yield grades as a function of days on feed.

30

19. The method of claim 16 wherein said movement pattern data is compared with said reference movement pattern data to determine a quality grade for each animal.
- 5 20. The method of claim 16 wherein said movement pattern data is compared with said reference movement pattern data to determine a back fat percentage of each animal.
21. The method of claim 16 wherein said movement pattern data is
10 compared with said reference movement pattern data to determine a weight group for each animal.
22. The method of claim 15 wherein said movement pattern data is compared with said reference movement pattern data to determine market ready
15 animals.
23. The method of claim 22 further comprising the step of changing feeding patterns for market ready animals thereby to reduce greenhouse gas production.
20
24. The method of claim 23 further comprising the step of calculating reductions in greenhouse gas production and selling the greenhouse gas reductions as offsets to greenhouse gas producers.
- 25 25. A system for monitoring the movement of animals within an area comprising:
a plurality of data collection and transmission units, each being carried by a respective animal, each of said data collection and transmission units transmitting animal position data over a wireless communications link; and
30 a processor in communication with said data collection and transmission units via said wireless communication link and receiving said animal position data, said processor processing said animal position data to generate data

representing movement patterns of said animals and analyzing said movement pattern data to determine at least one physical condition of said animal.

26. A system as defined in claim 25 wherein said processor includes a
5 database storing reference movement pattern data representing typical movement patterns of animals having physical conditions of interest, said processor comparing said movement pattern data with said reference movement pattern data to determine animals exhibiting one of more physical conditions of interest.
- 10 27. A system as defined in claim 26 wherein said reference movement pattern data represents typical movement patterns of animals suffering health problems.
28. A system as defined in claim 27 wherein said area is divided into at
15 least two zones including a food zone and a water zone and wherein said movement pattern data is compared with said reference movement pattern data to determine the duration and frequency animals spend in at least one of said zones thereby to detect animals likely suffering health problems.
- 20 29. A system as defined in claim 28 wherein said processor compares said movement pattern data with said reference movement pattern data to detect animals exhibiting one or more of the following movement characteristics:
- (i) more frequent and longer duration visits to said water zone;
 - (ii) less frequent visits to said food zone;
 - 25 (iii) generally overall decreased movement within said area;
 - (iv) more frequent and shorter duration visits to said water zone; and
 - (v) less frequent and shorter duration visits to said water zone.
30. A system as defined in claim 27 wherein said processor compares said
30 movement pattern data with said reference movement pattern data to detect animals exhibiting one or both of the following characteristics:
- (i) generally little movement within said area; and

(ii) circling in one direction.

31. A system for detecting animals exhibiting at least one physical condition of interest within a predefined area comprising:

5 a receiver receiving position data for each of said animals under observation at intervals;

a processor in communication with said receiver and processing said position data to generate a first database including data representing the movement pattern of each of said animals within said predefined area; and

10 a second database storing reference movement pattern data representing typical movement patterns of animals having physical conditions of interest, wherein said processor compares said movement pattern data in said first database with said reference movement pattern data in said second database to determine animals exhibiting one or more physical conditions of interest.

15

32. A program product comprising:

a computer-readable storage medium;

means recorded on the medium for processing animal position data to generate data representing the movement patterns of animals; and

20 means recorded on the medium to compare the movement pattern data with reference movement pattern data to determine at least one physical condition of said animals.

33. The method of claim 15 wherein said movement pattern data is
25 compared with said reference movement pattern data to detect overfeeding and underfeeding conditions of said animals.

34. The method of claim 22 further comprising the steps of stripping
market ready animals to slaughter and calculating reductions in greenhouse gas
30 production for sale as offsets to greenhouse gas producers.

35. A system as defined in claim 26 wherein said area is divided into at least two zones including a food zone and wherein said movement pattern data is compared with said reference movement pattern data to determine a yield grade for each animal as a function of days on feed.

5

36. A system as defined in claim 26 wherein said area is divided into at least two zones including a food zone and wherein said movement pattern data is compared with said reference movement pattern data to determine a quality grade for each animal as a function of days on feed.

10

37. A method for tracking the movement of animals as said animals are moved from location to location during processing comprising the steps of:

tagging each animal under observation; and

tracking the location of each tagged animal and the duration each

15 tagged animal spends at each location as it is moved to generate data representing each tagged animal's movement history.

38. The method of claim 37 wherein the generated data representing each tagged animal's movement history represents the tagged animal's movement generally
20 over its lifespan.

39. The method of claim 38 wherein said locations include ranches, backgrounders, feedlots and packers.

25 40. The method of claim 37 further comprising the step of using the generated data to detect tagged animals that have been in physical proximity with a tagged animal diagnosed with a transmittable disease.

41. The method of claim 37 further comprising the step of using the
30 generated data to detect locations that may be the cause of a trend exhibited by specific tagged animals.

42. The method of claim 37 wherein in at least one of said locations, the movement of animals within an area is monitored, said monitoring step comprising the steps of:
- collecting positional data of each animal under observation;
 - 5 processing said positional data to generate data representing the movement patterns of said animals; and
 - analyzing said movement pattern data to determine at least one physical condition of said animals.
- 10 43. The method of claim 42 wherein said positional data is collected at intervals.
44. The method of claim 43 wherein during said analyzing step said movement pattern data is compared with reference movement pattern data stored in a
- 15 database representing typical movement patterns of animals exhibiting said at least one physical condition.
45. A system for tracking the movement of tagged animals as said animals are moved from location to location during processing comprising:
- 20 at each location, a reader to read the tag on each of said animals thereat; and
- a processor in communication with said reader, said processor storing a record of each tagged animal's duration at said location.
- 25 46. A system as defined in claim 45 wherein the records stored by the processors at each location are combined in a database to provide data representing each tagged animal's movement history from location to location.

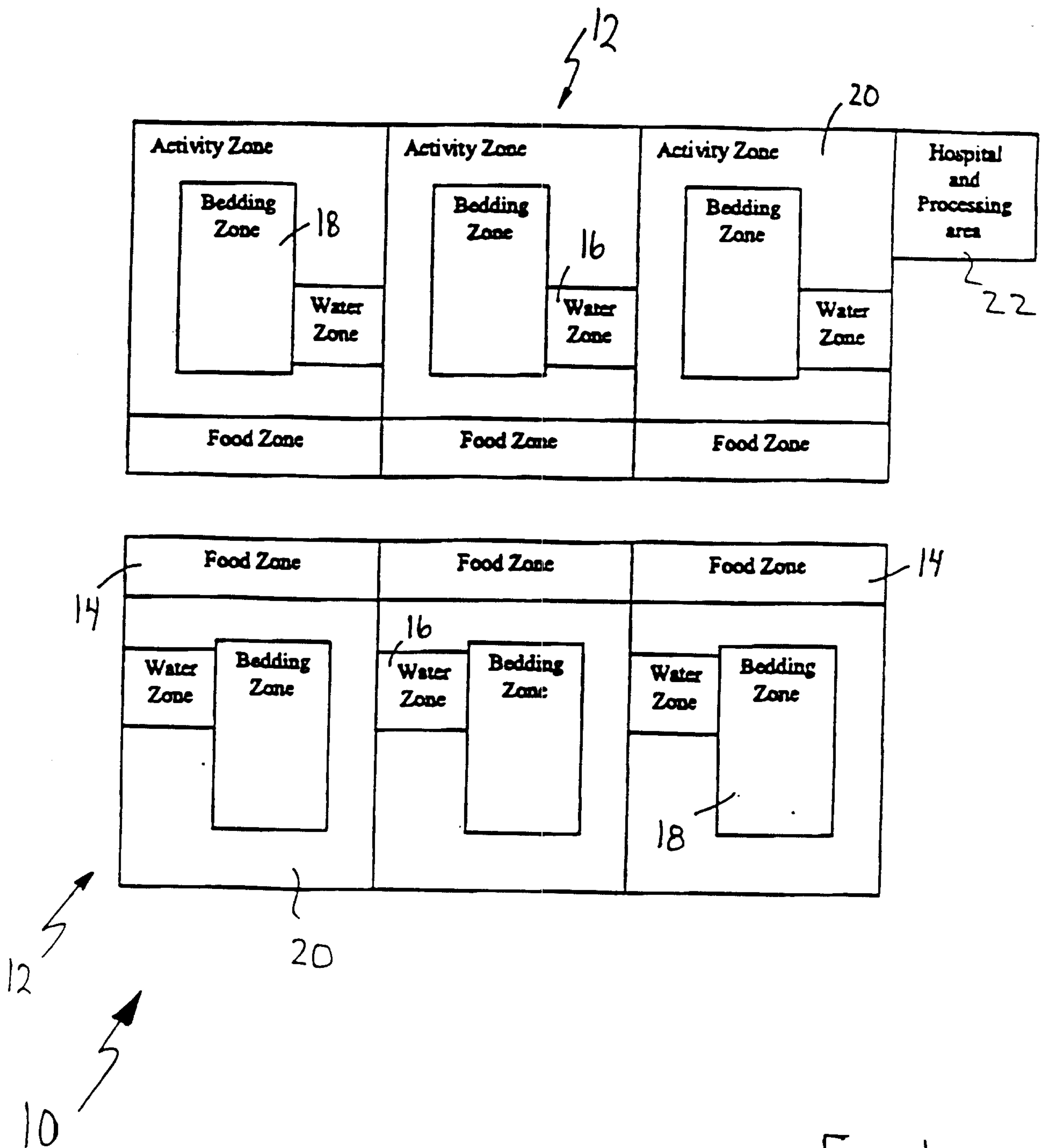


Fig. 1

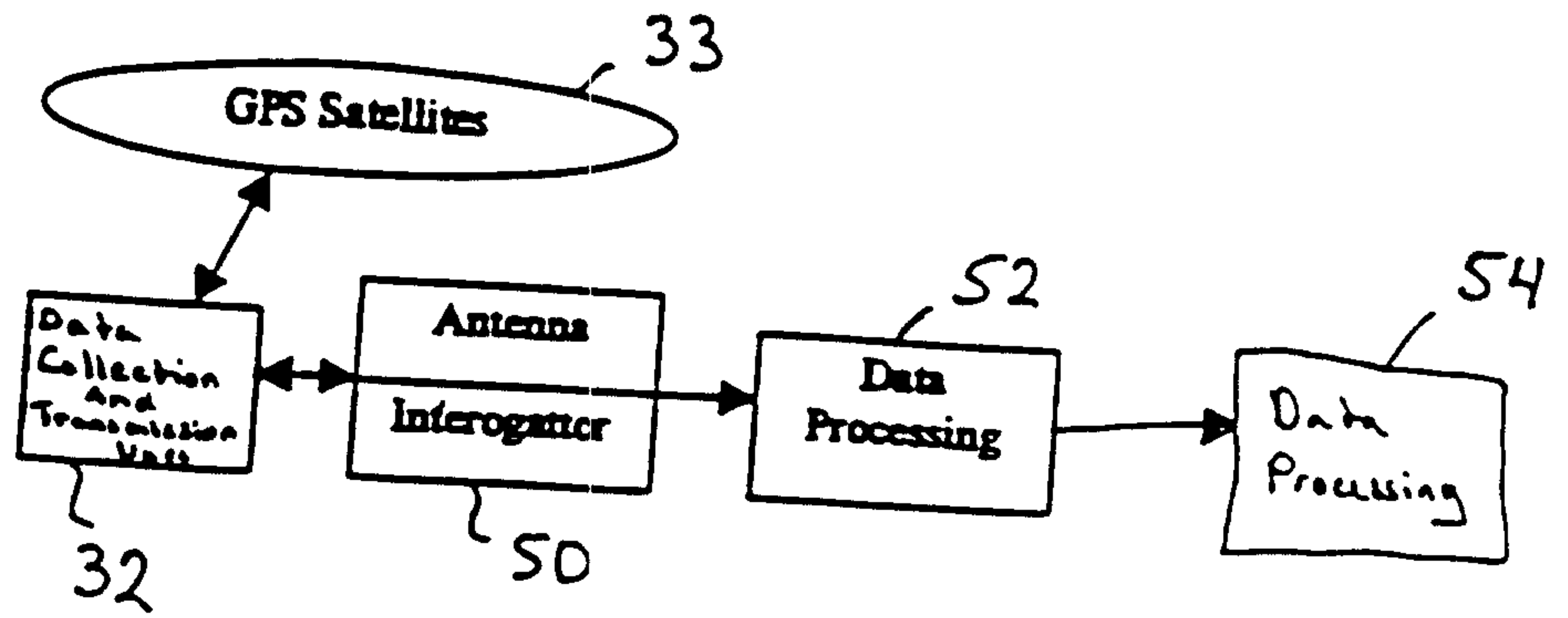


Fig. 2

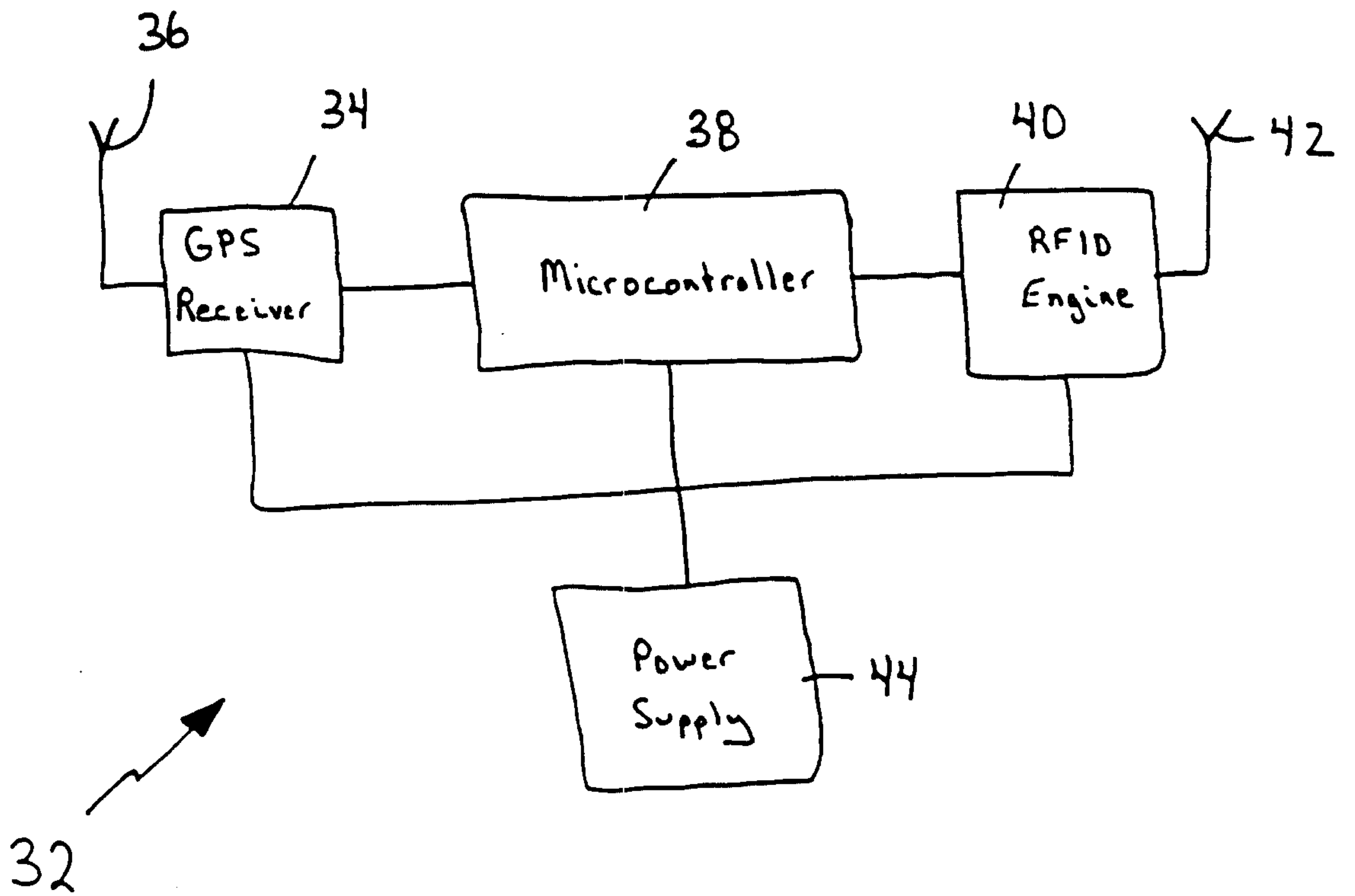
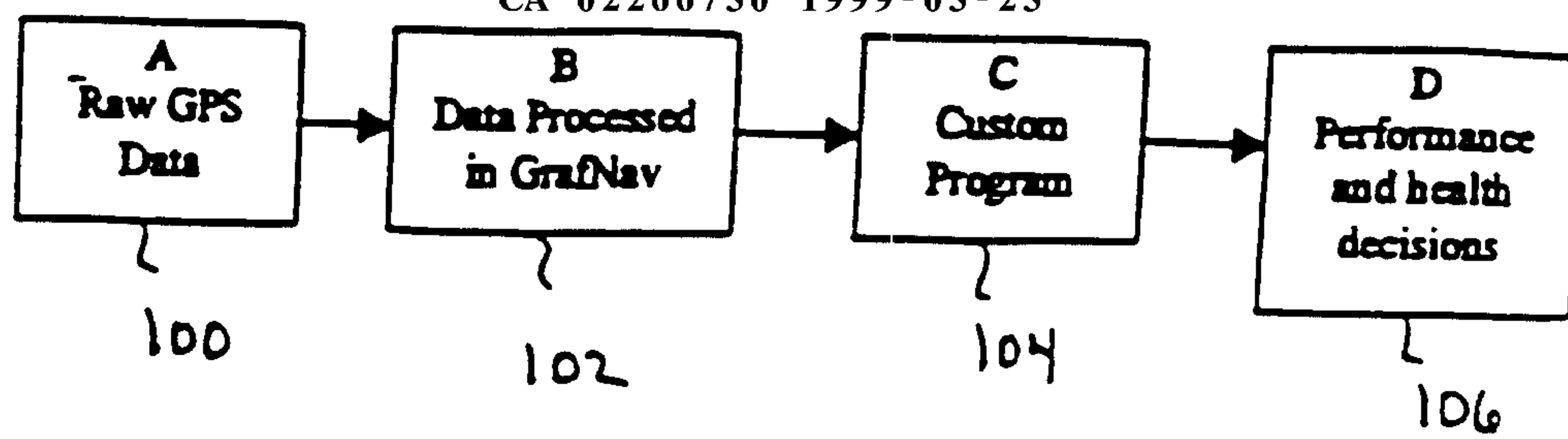


Fig. 3

Fig. 4**Ranchers**

R1: Kamloops
R2: Kelowna
R3: Lethbridge
R4: Swift Current

Backgrounders

B1: Cochrane
B2: Cardston
B3: Taber
B4: Regina

Feeders

F1: Acme
F2: Vegreville
F3: Langdon
F4: Strathmore

Packer

P1: High River
P2: Medicine Hat
P3: Calgary

Fig. 8

<u>Animal Health</u>	
<u>Animal</u>	<u>Days on Feed</u>
A	40
B	65
C	135
D	10
•	•
•	•
•	•

<u>Zone Definition</u>	
Feedlot Pen A	
<u>Zone</u>	<u>XY Coordinates</u>
14	{Data Set}
16	{Data Set}
18	{Data Set}
20	{Data Set}
•	•
•	•
•	•

<u>Physical Condition Table</u>		
<u>Animal Health</u>		
	Respiratory Disorder	Reference Movement Pattern Data 1
	Gastrointestinal Disorder	Reference Movement Pattern Data 2
	•	•
	•	•
	•	•
<u>Performance Characteristics</u>		
	Yield Grade 1	Reference Movement Pattern Data 10
	Yield Grade 2	Reference Movement Pattern Data 11
	•	•
	•	•
	•	•
	Quality Grade Prime	Reference Movement Pattern Data 15
	•	•
	•	•
	•	•
<u>Production Characteristics</u>		
	Market Ready	Reference Movement Pattern Data 20
	•	•
	•	•
	•	•

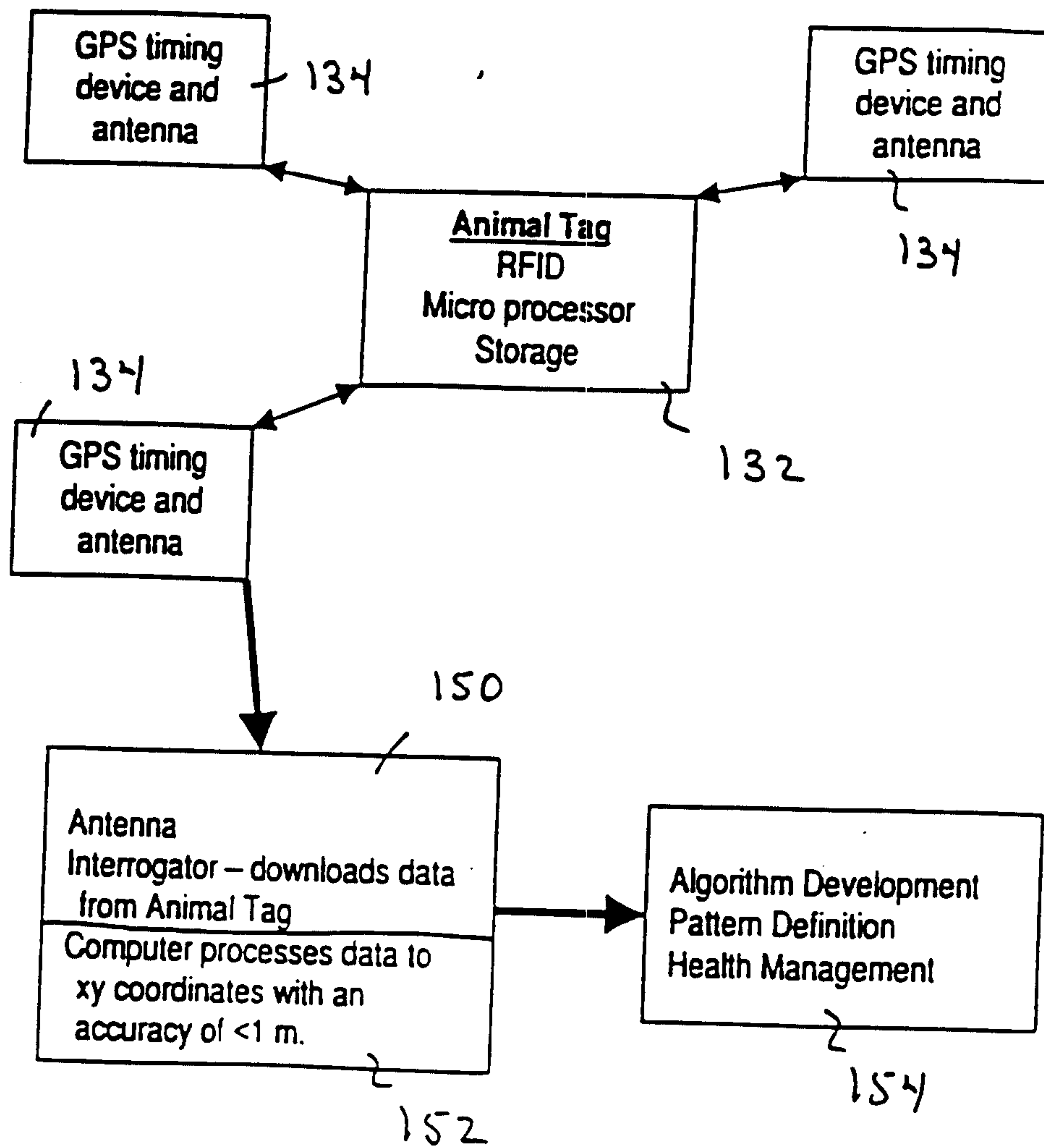
Figure 5a

Reference Movement Pattern Data 1	Frequency Water Zone (High) $\geq a$ Duration Water Zone (High) $\geq b$ Frequency Food Zone (Low) $\leq c$ Duration Food Zone (Low) $\leq d$ Overall Activity (Low) $\leq e$
Reference Movement Pattern Data 2	Frequency Water Zone (High) $\geq a$ Duration Water Zone (Low) $\leq b$ Frequency Food Zone (Low) $\leq c$ Duration Food Zone (Low) $\leq d$
• • •	• • •
Reference Movement Pattern Data 10	Frequency Food Zone (High) $\geq a$ Duration Food Zone (High) $\geq b$ Days on Feed $\geq F$
• • •	• • •
Reference Movement Pattern Data 20	Frequency Food Zone (Med) $\leq a$ Frequency Food Zone (Med) $\geq c$ Duration Food Zone (Med) $\leq b$ Duration Food Zone (Med) $\geq d$ Days on Feed $\geq g$

Figure 5b

<u>Tag Number</u>	<u>X</u>	<u>Y</u>	<u>Time</u>	<u>Zone In</u>	<u>Zone From</u>
A	x_1	y_1	11:01	14	20
A	x_2	y_2	11:15	14	14
A	x_3	y_3	11:25	14	14
A	x_4	y_4	11:35	14	14
A	x_5	y_5	11:45	16	14
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•

Figure 5c

Fig. 6

Frequency / Duration at Feed by Yield Grade and Weeks on Feed
Note that at week 8 the animals are slaughtered and the Yield grade measured.

APP by Yield Grade and Week on Feed

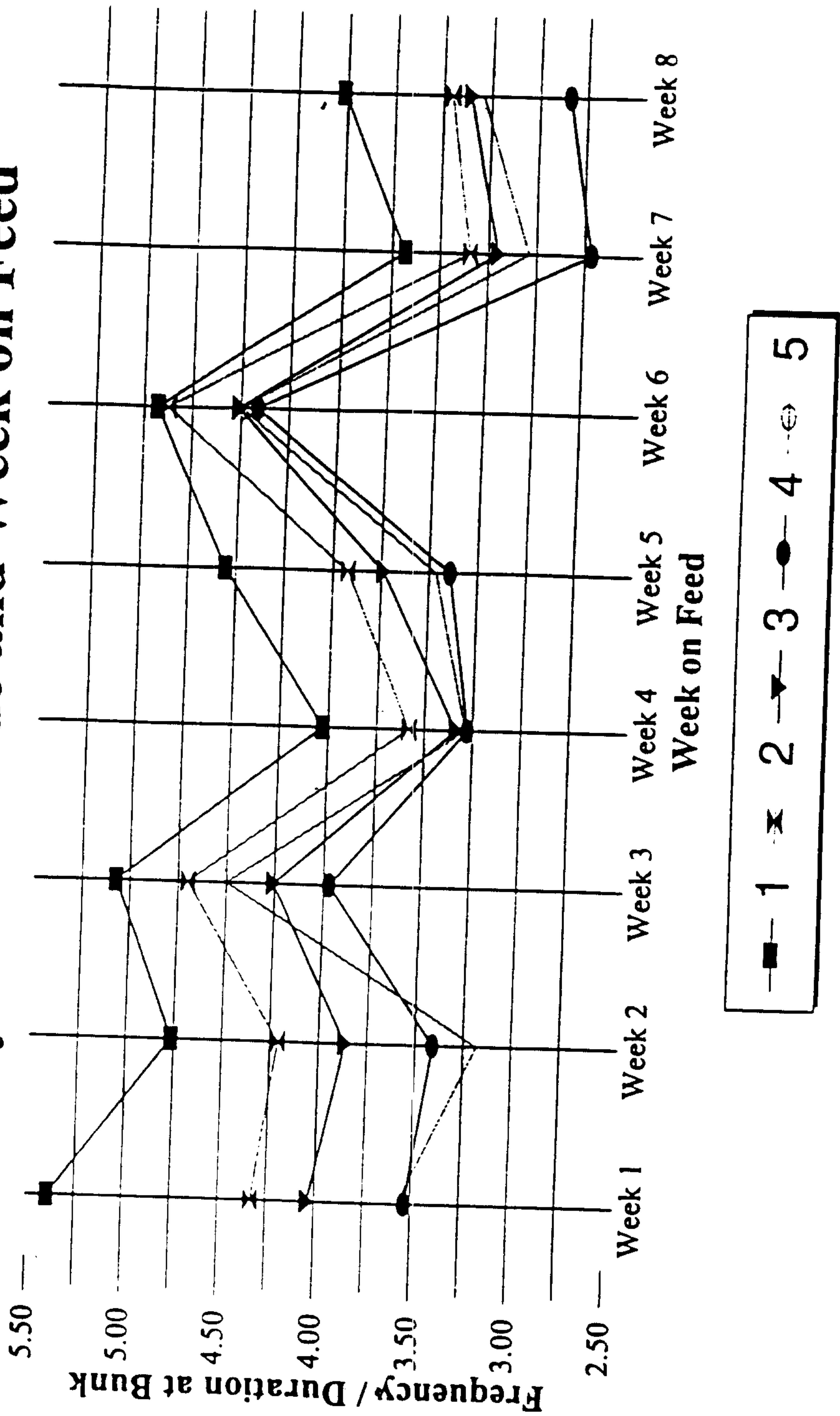
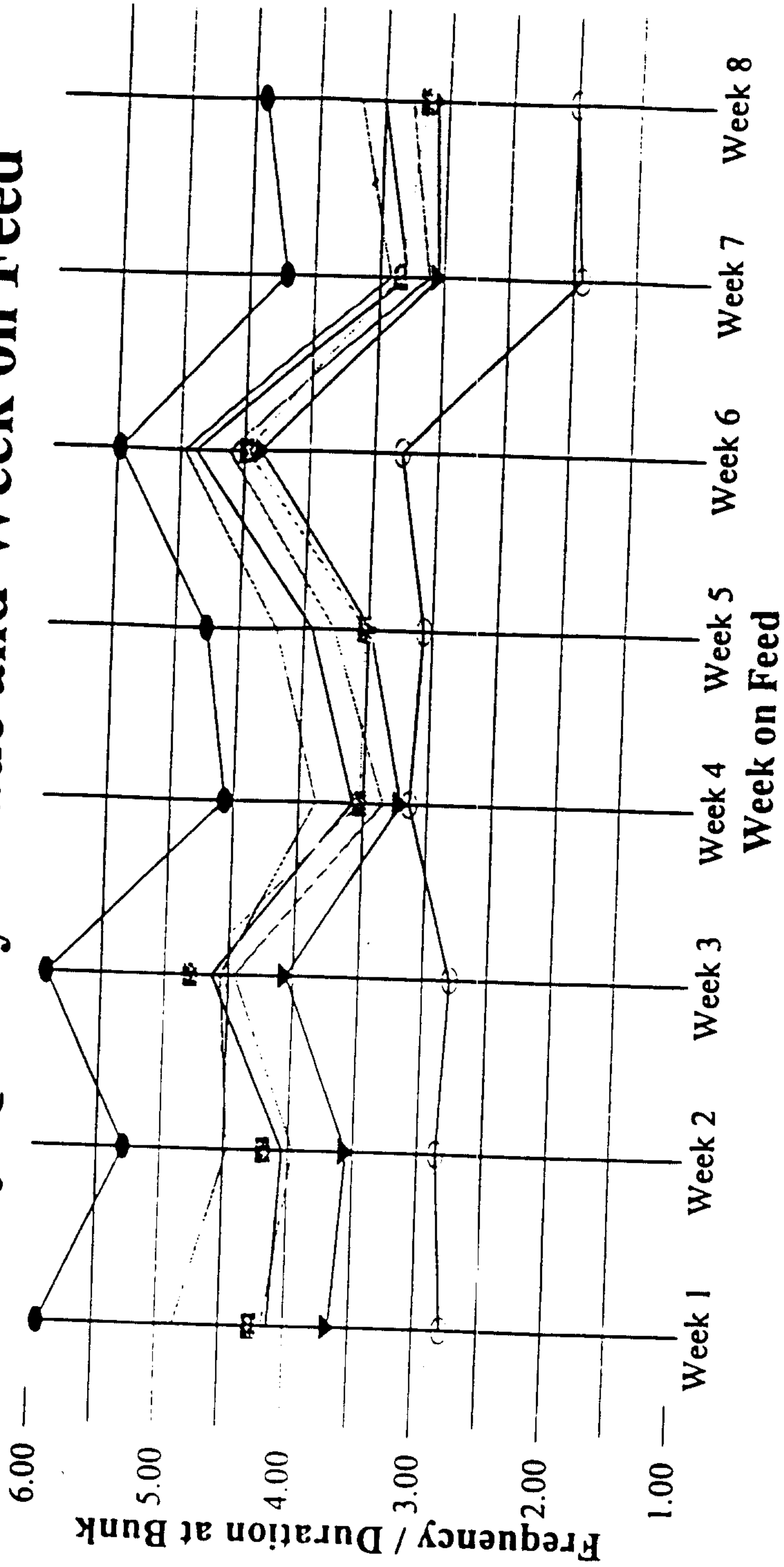


Fig. 7a

Frequency / Duration at Feed by Quality Grade and Weeks on Feed

APP by Quality Grade and Week on Feed



Ch + Ch 0 Sel + Sel 0 Std c

Fig. 7b

Frequency / Duration at Feed sorted by Back Fat at slaughter

Appearances by Back Fat and Week

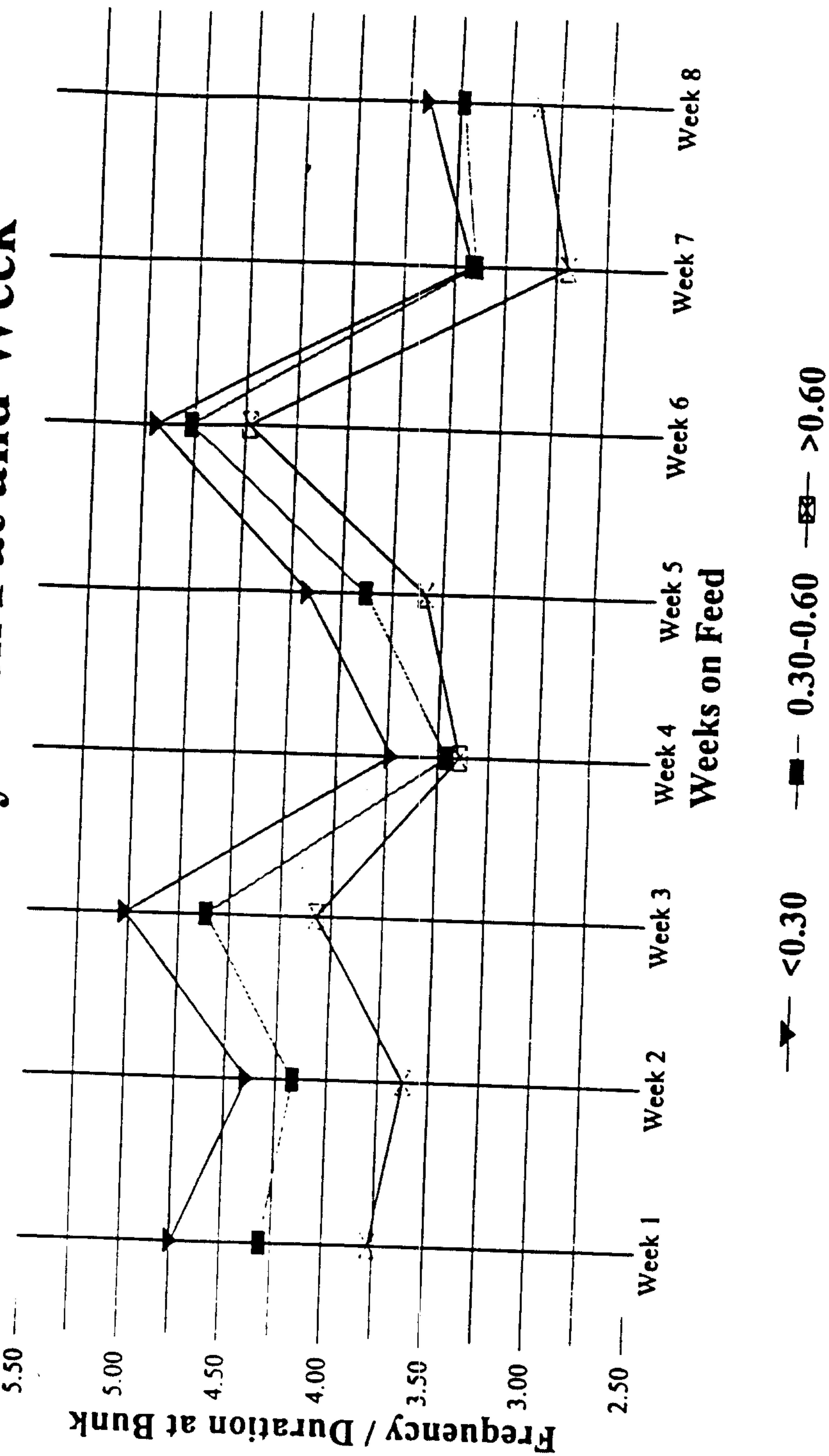


Fig. 7c

Frequency / Duration at Feed by Weight Group

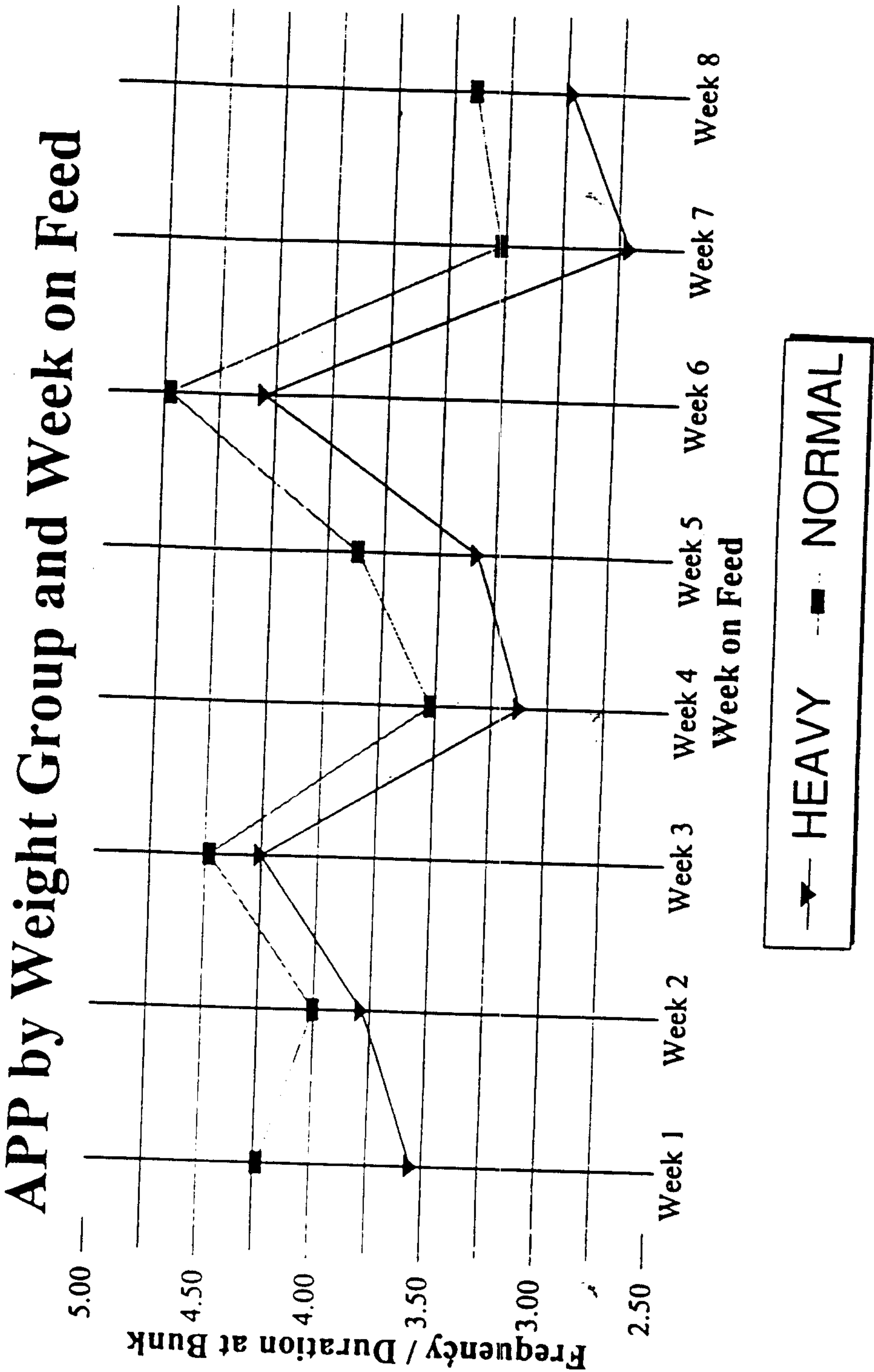


Fig. 7d