User Manual

Document Revision History

Version	Date	Author	Changes
0.1	20.02.2017	S. Ziegler	Initial version
0.2	14.05.2017	S. Ziegler	Update web interface
0.3	08.08.2017	S. Ziegler	Configure alarms Display delta
1.0	06.11.2017	J. Deicher	Release
1.01	29.11.2017	S. Ziegler	Description update interval
1.02	31.03.2018	S. Ziegler	Description hive activity alarm and food reserves indicator
1.02-EN-01	14.05.2018	K. Pfeiffer	Initial draft – English (V1.02); add'l. detail on Timeline navigation
1.03	30.05.2018	S. Ziegler	Updated images

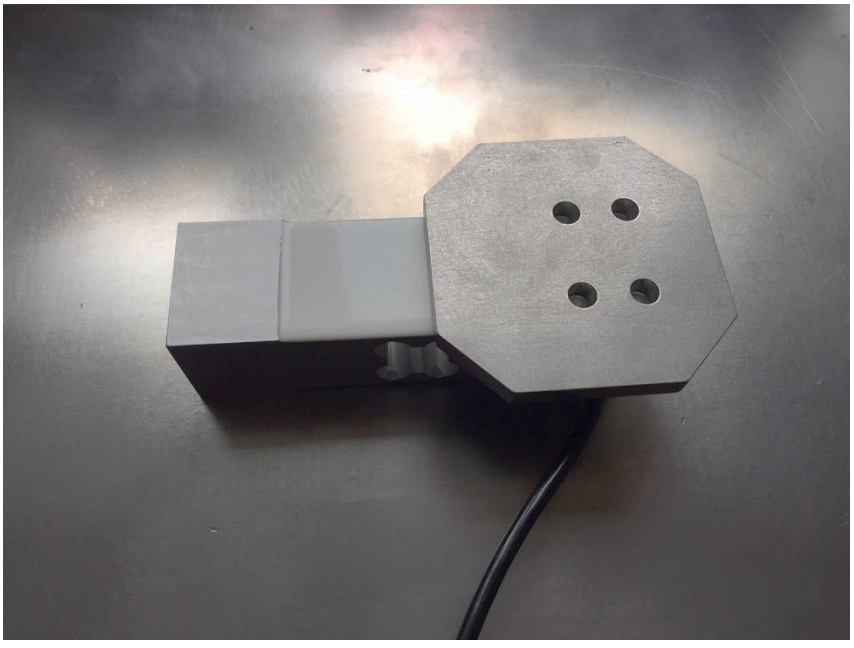
1 Installation

1.1 *Hive scale*

Each HiveWatch scale consists of the following components:

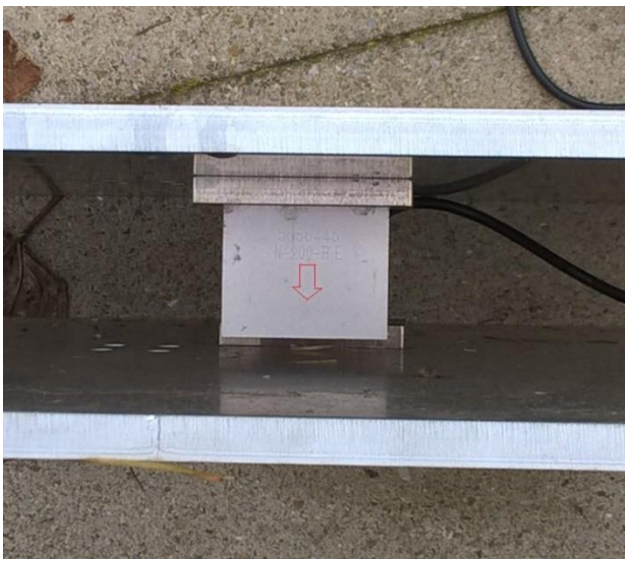
- 8 flat-head socket cap screws M8 X 30 (requires 5.0 mm Allen key)
- 2 aluminium platform plates (size varies)
- 2 spacer plates
- 1 load cell including connector cable
- Optional: extension cable 3 m / 5 m

Installation is not difficult, requiring only attachment of the two platform plates and spacers to the load cell using the machine screws provided; however, the use of work gloves is recommended. Please note: **The spacers are not symmetric and must be installed as shown:**



After correct positioning of the spacers, the top and bottom plates must be set in place such that the load cell is correctly centred between them and then secured with the mounting screws provided. To ensure maximum platform stability, these must be thoroughly tightened. After initial attachment of the top and bottom plates and hand-tightening of all eight screws, the fasteners must then be drawn fully tight. The scale

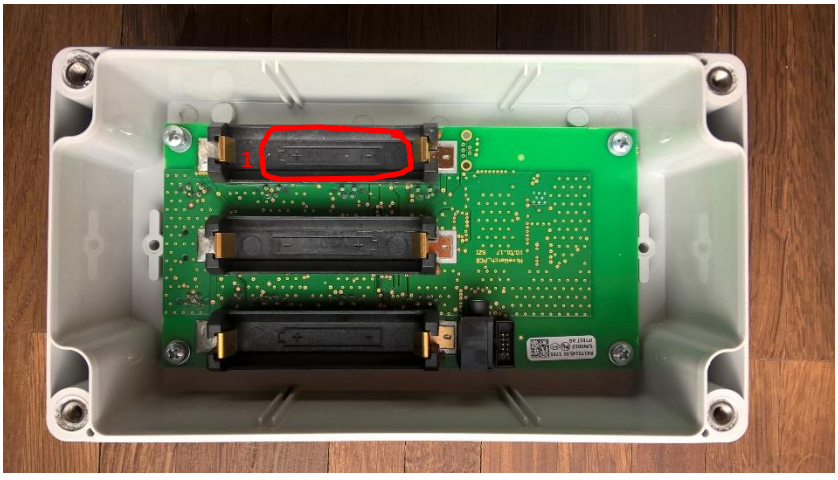
should then be turned on edge and the screws firmly tightened a second time. Note the small arrow visible on the side of the load cell. **The scale must be placed under the hive with this arrow pointing down:**



Depending on the specific load cell used, the arrow may be in another location (e.g., on the side).

1.2 *Batteries*

To install or replace the batteries in the transmitter, remove the four screws on the rear of the housing. Three standard AA batteries are required for operation and must be installed with the correct polarity as shown on the battery holders (1). Note that once installed, batteries may be difficult to remove. The easiest method is to twist them out sideways by hand. **Do not try to pry them out with a tool such as a screwdriver or use excessive force, as this can damage the battery holders!**



Not all batteries are suitable for outdoor use. Standard alkaline batteries are particularly unsuitable for low-temperature use and are not recommended. Primary (single-use) lithium batteries, such as Energizer Ultimate Lithium or Varta Lithium, are optimal for use, as they have a very low self-discharge rate and function well even at below-freezing temperatures:

With the use of either of these batteries, an operating lifetime of one to two years is possible. As an alternative, rechargeable NiMH batteries can also be used. These, however, have a substantial self-discharge rate (as much as 50% in six months) and store considerably less energy than do primary lithium batteries, resulting in a lifetime of only four to six months.

1.3 *SIM card*

The mobile SIM card is pre-installed in the transmitter and cannot be replaced or removed as it is permanently soldered to the circuit board. This ensures reliable transmission and network signal quality, as customary SIM cards are not intended for

use in below-zero temperatures. The pre-installed SIM card functions in global roaming mode. In Switzerland, for example, all three mobile networks (Swisscom, Sunrise and Salt) are supported. The SIM card may not be removed or used outside the transmitter.

1.4 *Connecting the scales to the transmitter*

Hive scales can be plugged into any one of the eight channels on the transmitter. Ensure that the pins are aligned correctly before attaching and tightening each connector.

Properly aligned, the four-pin connector is easily inserted and the sleeve tightened with little resistance. **As this is an extremely accurate measuring system, it is important that the contacts do not become contaminated or come into contact with water.** Installation should be carried out in good weather to ensure that no moisture, dust or dirt enters the connectors.

Hive scales should always be set up on a stable, level surface. Otherwise the load acting on the scale splits into a horizontal and a vertical component, resulting in a weight measurement that is too low, as the load cell will only register the vertical component. In the most extreme (theoretical) case, with the scale on its side, no force would be registered at all.

1.5 *Placement of the transmitter*

The transmitter should be placed in a location protected from rain and snow and positioned such that neither rain nor moisture can run along the cables and enter a connector plug.

For optimal results with the internal temperature sensor (site temperature), the transmitter should be shielded from the sun, otherwise the housing will heat up and readings will be too high.

1.6 *Operation*

The transmitter functions automatically. As soon as the batteries have been installed, it begins to log weight measurements once per minute for each channel and at a pre-determined interval upload the stored data to the HiveWatch web server. (Initial activation of the SIM card may take up to 24 hours.) On-demand data transfer and other system operations are possible by means of a pushbutton on the transmitter (1). The following functions are possible:

1) Button press less than one second: Initiates a data upload to the HiveWatch server. The Status LED (2) will blink green. As soon as a connection has been successfully established, it will report signal strength as follows:
    a. Solid green: Excellent
    b. Flashing green once per second: Good
    c. Flashing green twice per second: Moderate
    d. Flashing green four times per second: Weak

Should the data transfer fail, the Status LED will light up red for several seconds and then blink to indicate an error:

    a. Solid red: Hardware problem or batteries may need replacement
    b. Flashing red once per second: No mobile network detected
    c. Flashing red twice per second: No data connection
    d. Flashing red four times per second: Upload to server failed
    e. Solid orange (both green and red LEDs illuminated): Configuration on Web server not found

2) Button press longer than one second: Alarms deactivated (weight measurements continue to be logged) and the Status LED (2) blinks red for three seconds. After two hours, the alarms are automatically reactivated. If the pushbutton (1) is then pressed again for longer than one second, the Status LED will flash green for three seconds to indicate that the alarms are enabled. Pressing the pushbutton for less than one second while the alarms are inactive will cause the Status LED to blink red, confirming that the alarms have been disabled.

2 Accuracy

The load cell range is 200 kg, with a resolution of ±10 g. Resolution defines the minimal weight difference that can reliably be detected and bears no relation to absolute accuracy.

Absolute accuracy is related to measurement error – the amount of inaccuracy when, for example, a 100 kg weight is placed on the scale and compared to the weight measured by the scale. Absolute accuracy is mainly a limit of the load cell. These have a gain error of ≤2% and an offset error of ≤2% for the 200 kg load range. The offset error is less important – the beekeeper is interested in relative changes in hive weight, and (empty) hive weight anyhow varies. Gain error is also not a concern – applying the maximal 2% gain error to a 6 kg increase in weight, for example, yields a measurement error of 120 g.

Other factors affecting load cell accuracy include wind and temperature drift. Field tests have shown that wind effects can cause short-term measurement variations of up to 500 g. HiveWatch, however, records weight measurements sixty times per hour, allowing such factors to be easily filtered out by averaging readings over a number of minutes. Theoretically it might even be possible for the wind to trigger a false swarm alarm, but in practice this is extremely rare and would only occur under very strong wind conditions.

A load cell temperature drift of 20 to 50 g over the course of a 10°C (18°F) temperature swing is possible, particularly when cold nights alternate with warm days. Temperature compensation is not trivial, as the drift characteristics vary for each load cell. But given that weight measurements are drawn from roughly the same time of day when making comparisons, such minor deviations are not usually relevant in practice.

Ambient (site) temperature readings are accurate to ±2°C. Keep in mind, however, that although the HiveWatch transmitter is usually sited in the shade, hive boxes may be exposed to direct sun, thus the apparent temperature experienced by the colony may significantly vary from the temperature reading as recorded by the transmitter.

3 Alarms

Alarm events will trigger a notification message to be sent via SMS, e-mail or telephone; these can be individually configured. The various alarms are described in detail below.

3.1 *Swarm alarm*

The swarm alarm is activated when an extraordinary weight loss is detected. Eight minutes after the initial alarm, a data upload to the HiveWatch server is initiated. This makes it possible to examine the course of events leading up to and immediately following an alarm event, which is particularly helpful in cases of doubt.

False alarms

False alarms can occur under the following conditions:

a. Working the hive without first deactivating the swarm alarm (frequent)
b. Strong wind, particularly in exposed locations (very rare)
c. Hive not freestanding, contact with shrubs, walls, or other hives, etc. (rare)
d. Melting snow, ice, etc. falling from the hive (rare)

Such disturbances are usually easily classified as false alarms. In cases of doubt, a check of the Timeline will generally suffice to reveal a false alarm.

Undetected swarms

Very small swarms (less than 1 kg) may sometimes exit the hive so slowly that the weight change does not exceed the detection threshold of the swarm algorithm. An extremely reduced hive entrance may also limit the rate of departure of a swarm such that the resulting weight loss does not exceed the detection threshold.

3.2 *Hive disturbance alarm*

If a hive is physically disturbed, the hive disturbance alarm is activated and a notification sent. This may be due to theft, an overturned hive, or storm damage, for example.

Eight minutes after the alarm is triggered, a data upload to the HiveWatch server is initiated. This makes it possible to examine the course of events leading up to and immediately following the alarm event

3.3 *Hive activity alarm (robbing)*

The hive activity alarm makes it easier for the beekeeper to identify suspicious weight gradients at an early stage. In practice, a beekeeper will rarely analyse weight data on a daily basis; thus it often happens that an apparent case of robbing behaviour is discovered only days later. HiveWatch relies on an intelligent algorithm to monitor the weight curves of all connected hive scales and will automatically send an alert in the

event of an extraordinary weight-related event. The following two scenarios can be discerned:

1) Extraordinary weight gain: If two or more hive scales are connected to the transmitter, an extraordinary weight gain by only one hive will trigger an alarm. This can occur when the suspect colony is doing robbing. Such a scenario, however, can also occur when one colony has discovered a particularly rich source of nectar. Since these two cases cannot be distinguished solely on the basis of the weight plot, this scenario requires the additional judgment of the beekeeper and possibly an on-site inspection. The greater the number of hives connected to a single transmitter, the better this alarm will function. If only one hive scale is connected, the alarm is deactivated, as it is not possible to distinguish a normal honey flow from robbing without at least one additional hive as a point of reference.
2) Extraordinary weight loss: A sudden, continuous loss of weight in a hive – a strong indication of robbery – will also trigger the alarm.

False alarms

False alarms can occur under the following conditions:

a. Strong honey flow in a single colony. In this situation, it may be worth considering why the other colonies are not bringing in similar quantities of nectar.
b. Hive not freestanding, contact with shrubs, walls, or other hives, etc.
c. Melting snow

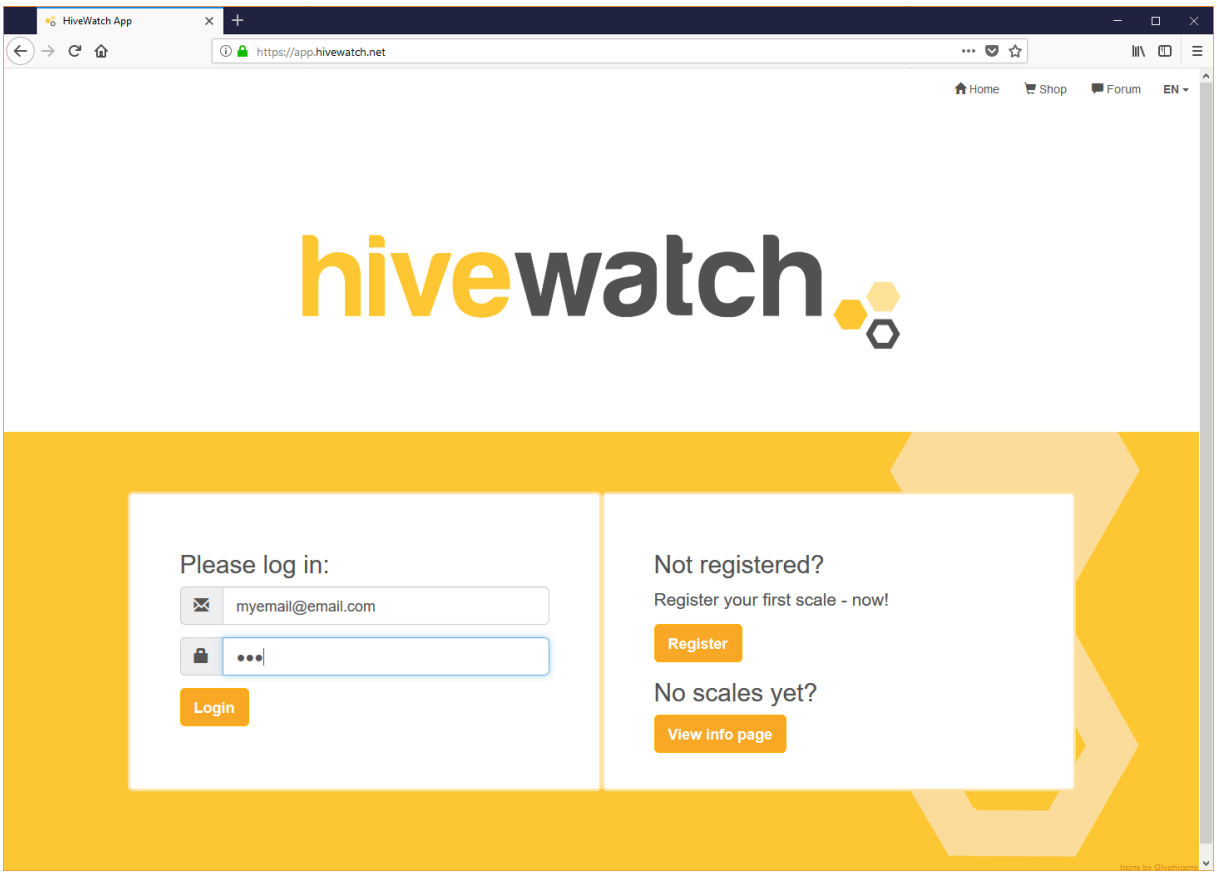
These situations can usually easily be classified as false alarms; in doubt, a look at the Timeline will generally suffice to confirm the false alarm.

4 Web interface

HiveWatch's web interface was developed in collaboration with the University of Applied Sciences Rapperswil (HSR) and tested with the Apple Safari, Google Chrome, Microsoft Edge, and Mozilla Firefox browsers. We recommend using one of these browsers to access HiveWatch.

4.1 *Login*

First stop is the login screen at www.hivewatch.net. After entering your username and password and clicking on Login, you will be redirected to the HiveWatch Dashboard.



4.2 *Dashboard*

The HiveWatch Dashboard displays a summary of all transmitters assigned to your user account as well as all connected hive scales (once the SIM card has been activated). The transmission time of the most recent update is shown for each hive scale (1). If a hive scale is disconnected, it will remain visible in the Dashboard, but no further updates will take place and the last values received will remained displayed. Regardless of whether a hive scale is connected or not, the time of the most recent data transfer from the transmitter is displayed (11).

HiveWatch polls local weather data (2) from an online service based on the configured location coordinates of the transmitter. The advantage of this approach is that these values are robust and not influenced by an incorrectly positioned or poorly functioning weather station. Under some circumstances, of course, this data may vary slightly from

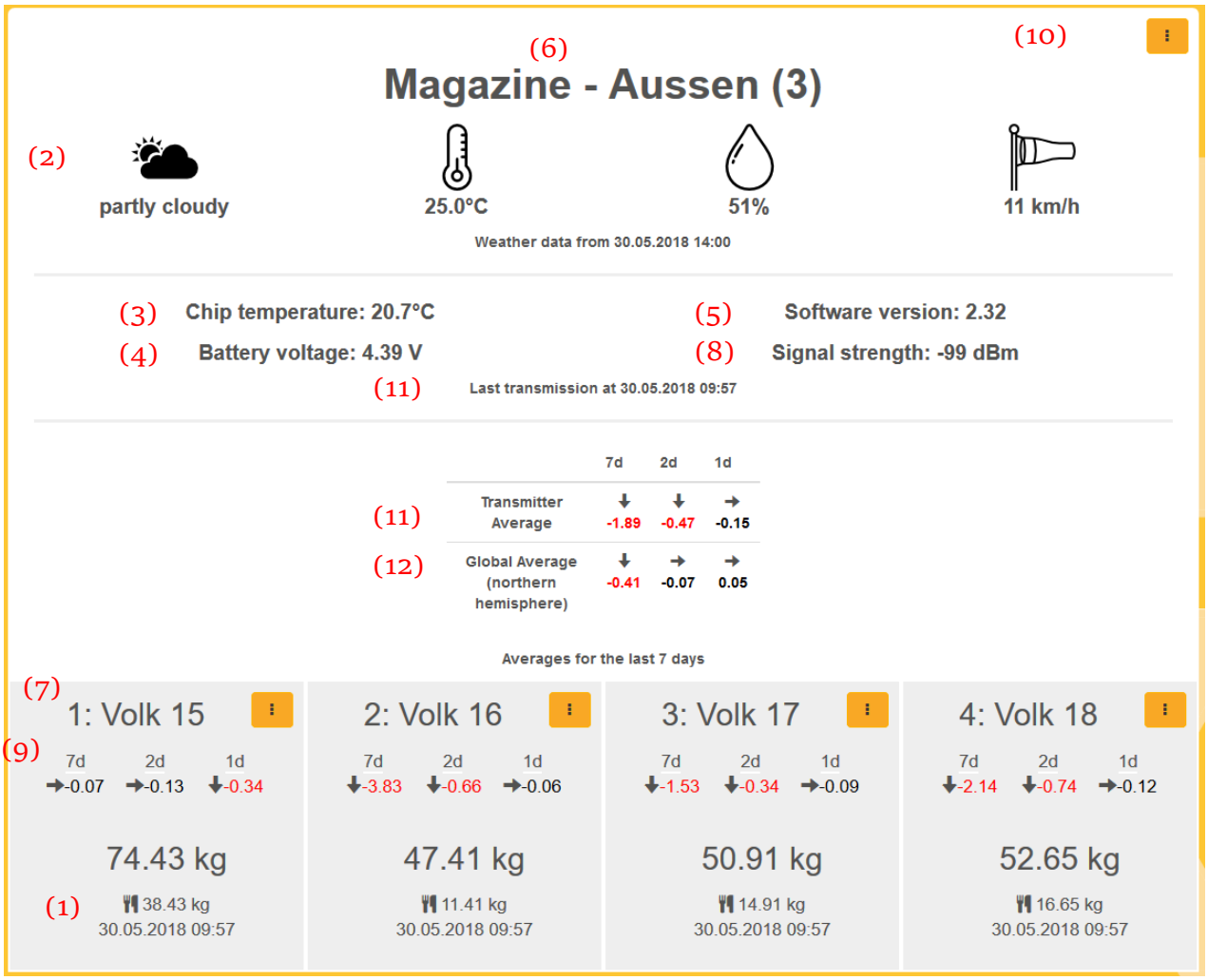
the readings observed at the actual transmitter location. The ambient site temperature (3) is recorded by the transmitter, but is only reported when a data upload occurs.

Transmitter battery voltage (4) is also displayed so that battery replacement can be planned ahead of time. The significance of the voltage displayed is dependent on the type of battery in use: Primary (non-rechargeable) lithium batteries are almost empty when the battery voltage drops below 4.2 V; for rechargeable NiMH cells the cut-off value is 3.5 V. For network reception (8), a signal strength of −80 to −50 dBm is very good, −100 to −80 good, and below −100 dBm weak.

Each HiveWatch transmitter is assigned a name (6), as is every hive scale (7). Configuration of names, etc., is found under the menu Settings (see 4.4). The software version (5) is displayed for informative purposes only.

For each hive scale, the weight change (delta) for the past 24 hours (1 d), 48 hours (2 d), and 7 days (7 d) are displayed (9). Data spikes due to interventions by the beekeeper are ignored. The weight changes are calculated at midnight local time, when the bees are likely to be in the hive. This provides a quick estimate of hive activity without the need to examine the Timeline, a feature that is especially useful when on a smart phone.

In the top-right corner of the Dashboard (10), the More Options (vertical ellipsis) button leads to additional functions, such as location configuration and display, deactivation of alarms, and general settings. The various types of alarm notifications can be deactivated for one or two hours with a single click without the need to press the pushbutton on the transmitter.



Site averages

Site Average (11) displays an average of the recent weight changes for all hive scales connected to the respective transmitter. In the example shown, this is the sum of the respective deltas divided by four, since four hive scales are connected. Here, too, spurious data spikes such as those due to an intervention by the beekeeper are filtered out.

Global Average (12) is just that: an average of the data reported for all HiveWatch systems world-wide (northern or southern hemisphere, depending on your location). This is of particular interest in springtime, when you can compare the progress of your own colonies to the trend at large. In winter you can follow the general food consumption trend, keeping in mind, of course, that this value will be influenced by snowfall. Strong deviations from the norm may also be a reflection of local conditions (snow, regional climate, etc.). It is up to the beekeeper to decide whether a hive inspection may be necessary. The greater the number of scales connected to a transmitter, the easier the final assessment.

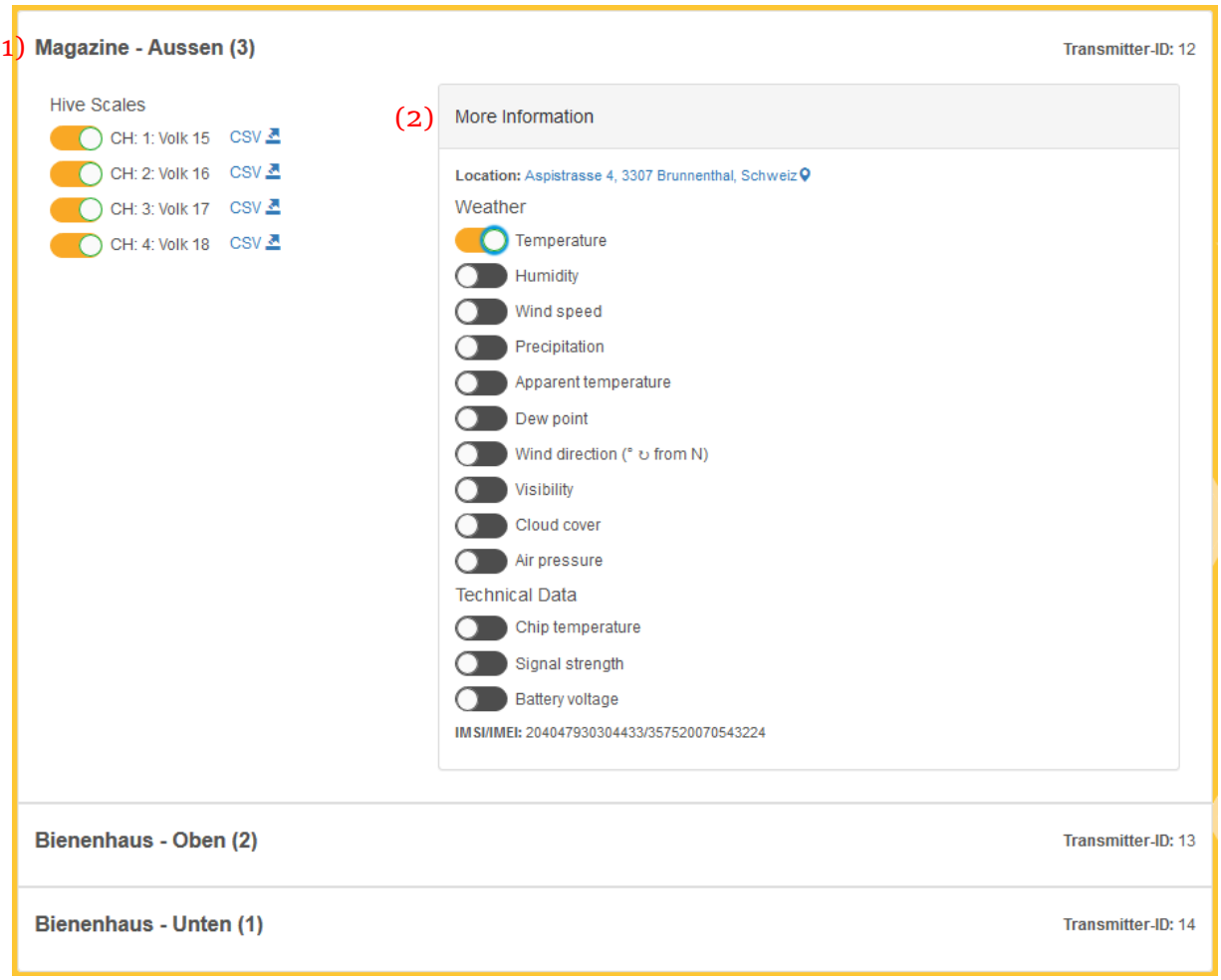
4.3 *Timeline*

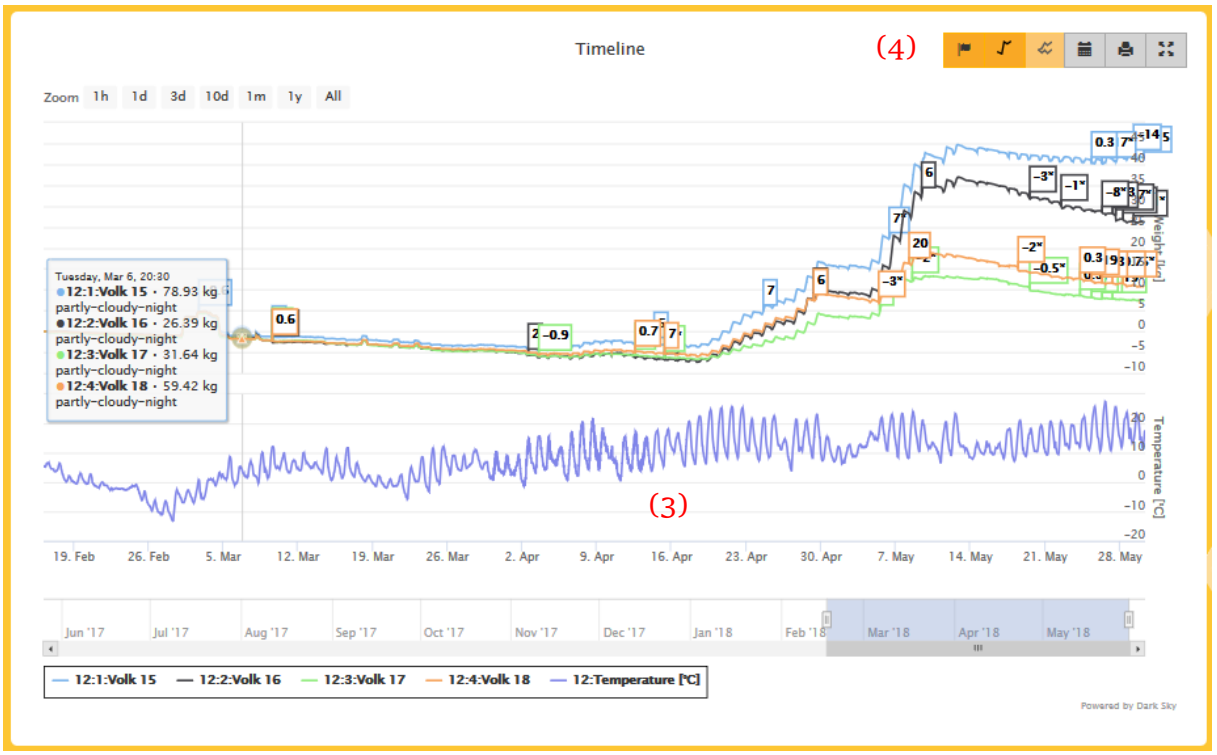
Clicking on the menu item Timeline opens the time plot window. Clicking on the name of the transmitter, in this case M (1), expands the frame to reveal the connected scales; these can then be toggled on or off as desired for display on the Timeline. Clicking on More Information allows various weather and other technical data to be included. These are displayed below the weight curves (3).

The grey buttons in the upper-right corner of the Timeline window (4) provide access to the following functions (from right to left):

- Full Screen
- Print
- Select date range
- Direct Comparison: The starting (leftmost) data point for each hive scale displayed is normalized to zero and the vertical range rescaled to fit the data. This allows the beekeeper to directly compare weight gains and losses between two or more hives, regardless of differences in starting weight.
- Clean data: Unnatural data spikes, such as those that occur during a hive inspection, are filtered out. This is particularly helpful when comparing weight gain as it also re-aligns the data to filter out the sudden jumps that occur, for example, when honey supers are added or removed, thus allowing for close monitoring of food reserves and accurate comparisons of hives.
- Flag interventions: This button automatically appears and is activated together with the Clean data function; when active, filtered weight changes (e.g., the addition or removal of a super) are visually flagged – a helpful reminder of recent or past modifications.

If the selected measurement period is less than three days, every data point is displayed – 60 measurements per hour. For ranges greater than three days, an hourly average is displayed to avoid excessive data downloads, which is especially important for smartphone use.


(1) Magazine - Aussen (3)
Transmitter-ID: 12
Hive Scales
CH: 1: Volk 15 CSV
CH: 2: Volk 16 CSV
CH: 3: Volk 17 CSV
CH: 4: Volk 18 CSV
(2)
More Information
Location: Aspistrasse 4, 3307 Brunnenthal, Schweiz
Weather
Temperature
Humidity
Wind speed
Precipitation
Apparent temperature
Dew point
Wind direction (° ↻ from N)
Visibility
Cloud cover
Air pressure
Technical Data
Chip temperature
Signal strength
Battery voltage
IMSI/IMEI: 204047930304433/357520070543224
Bienenhaus - Oben (2)
Transmitter-ID: 13
Bienenhaus - Unten (1)
Transmitter-ID: 14


Timeline
(4)
Zoom 1h 1d 3d 10d 1m 1y All
Tuesday, Mar 6, 20:30
12:1:Volk 15 · 78.93 kg
partly-cloudy-night
12:2:Volk 16 · 26.39 kg
partly-cloudy-night
12:3:Volk 17 · 31.64 kg
partly-cloudy-night
12:4:Volk 18 · 59.42 kg
partly-cloudy-night
Weight [kg]
Temperature [°C]
(3)
19. Feb 26. Feb 5. Mar 12. Mar 19. Mar 26. Mar 2. Apr 9. Apr 16. Apr 23. Apr 30. Apr 7. May 14. May 21. May 28. May
Jun '17 Jul '17 Aug '17 Sep '17 Oct '17 Nov '17 Dec '17 Jan '18 Feb '18 Mar '18 Apr '18 May '18
12:1:Volk 15
12:2:Volk 16
12:3:Volk 17
12:4:Volk 18
12:Temperature [°C]
Powered by Dark Sky

The Select Date Range button in the upper-right corner of the Timeline window provides a useful drop-down calendar for selecting the time period by day, month, or even year, but there are three other ways to navigate the Timeline.

Zoom factor buttons

The buttons in the upper-left corner of the Timeline offer additional preset zoom factors: 1 h, 1 d, 3 d, 10 d (default), 1 m, 1 y, and All. Please note these scale from the right – the most recent (right-most) point in time remains fixed and the data "zooms" on the left.

Timeline click-and-drag to zoom

Perhaps the easiest way, however, to zoom in on an already established date range is to click and drag directly in the Timeline plot itself. Click on one of the presets to zoom out if you find that you have zoomed in too far.

Timeline ribbon

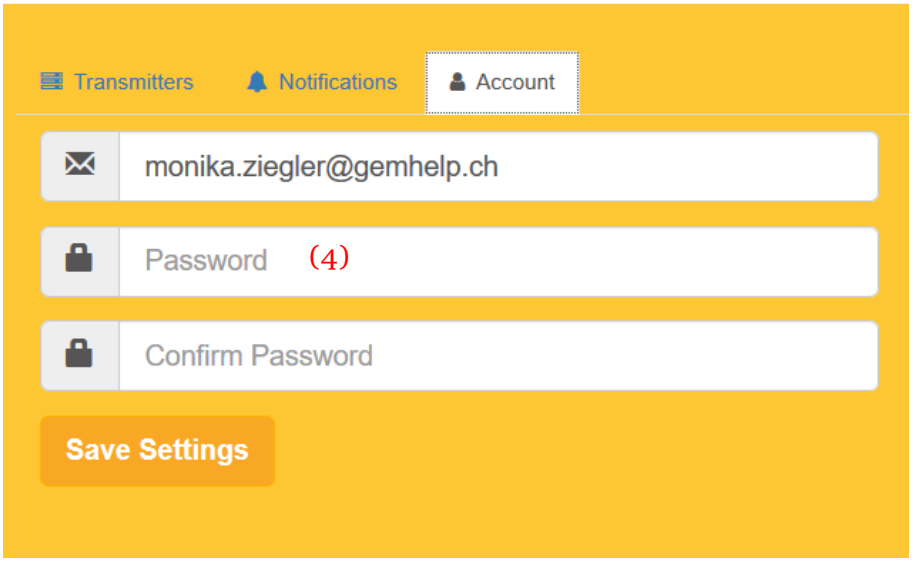
At the bottom of the Timeline window is the timeline ribbon. Drag either of the two handles left or right to reset the start and stop dates; drag the bottom handle, or the currently displayed time range itself (the grey field on the ribbon) to simultaneously change both start and stop dates without altering the zoom factor. Like the date range button, the timeline ribbon is particularly useful for historical comparisons.

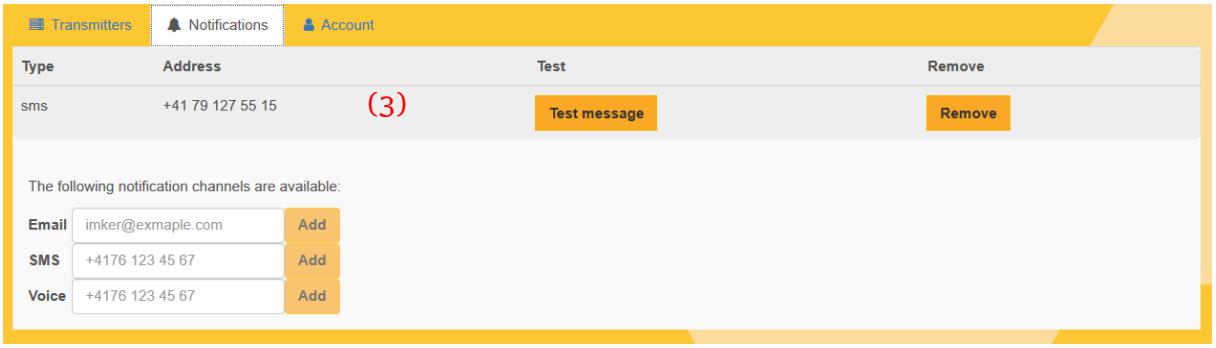
4.4 *Settings*

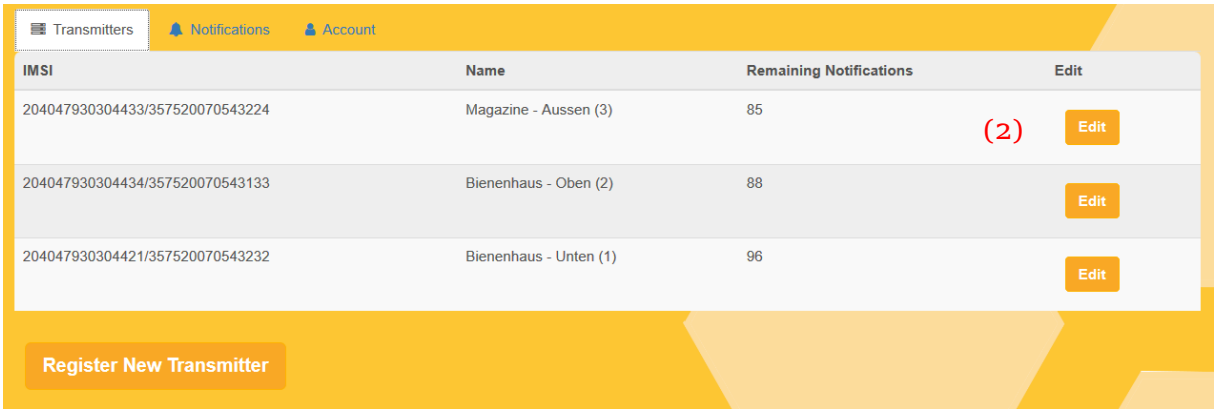
Under Settings you can:

1) Choose a new password. (4)
2) Assign a site name to a transmitter, temporarily disable alarms, hide or display hive scales and set transmitter location. (2)
3) Configure alarm notification options. (3)

A notification can be sent via e-mail, SMS, or voice telephone. Simply enter the necessary information and click on Add. Test Message will trigger the respective SMS, e-mail or phone call notification, allowing you to verify correct function; this is highly recommended. Multiple telephone numbers and e-mail addresses can be configured.







Clicking on the Edit button (2) opens a new window with the three tabs General Settings, Hive Scales, and Notifications.

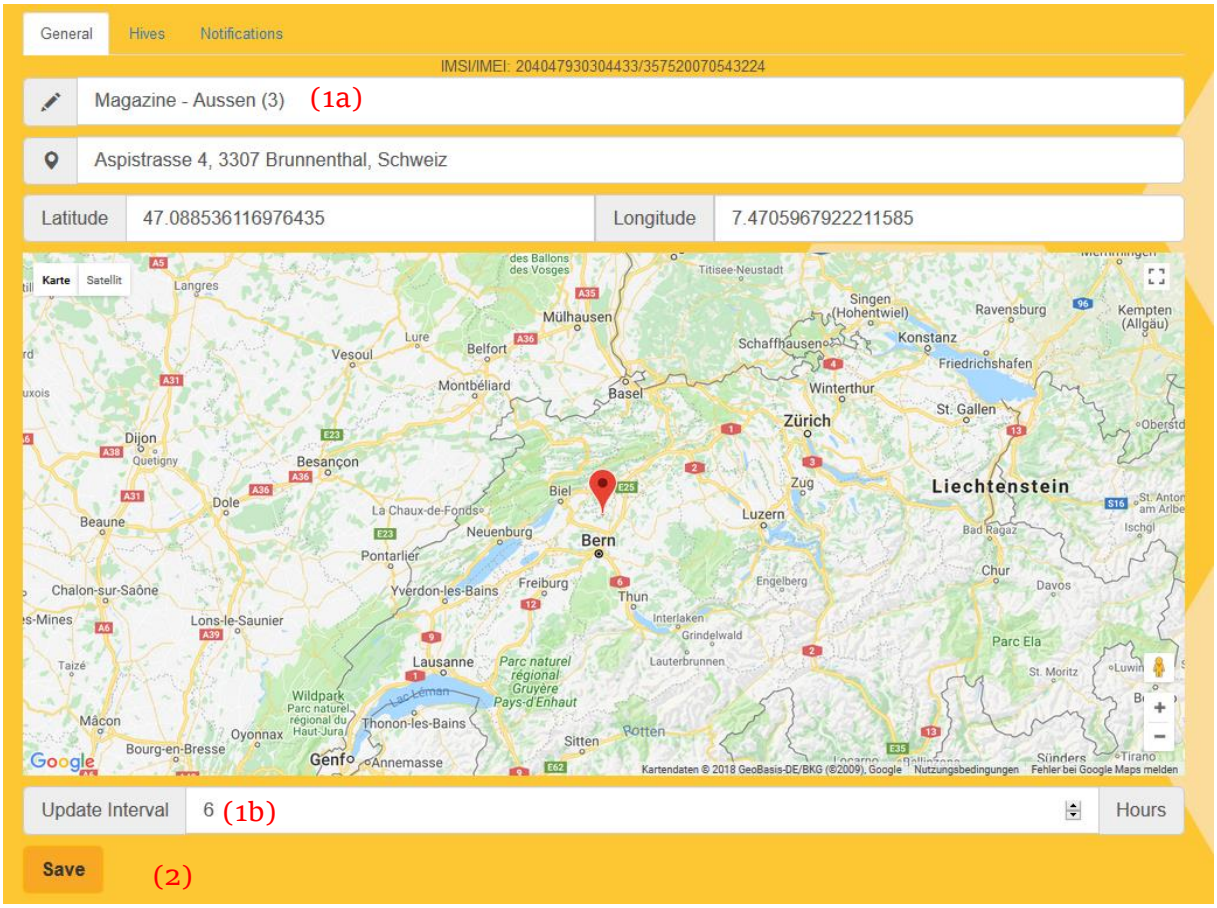
Site

In the first field, the transmitter can be assigned an appropriate site name (1a), which will then be displayed in the Dashboard, the Timeline, and in alarm notifications. Thus it is wise to select a meaningful name.

The GPS coordinates of the transmitter can be set by dragging the marker in the map to the transmitter location. This is necessary for the correct weather information to be shown.

The update interval (1b) determines how often recorded data is transferred to the HiveWatch server. The maximum value is six hours, resulting in a battery life of approximately 1.5 years. With a four-hour transmission interval, the batteries should last for more than a year, less for a more frequent interval. The minimum configuration is hourly.

Click on Save (2) to store the configuration.



Hives

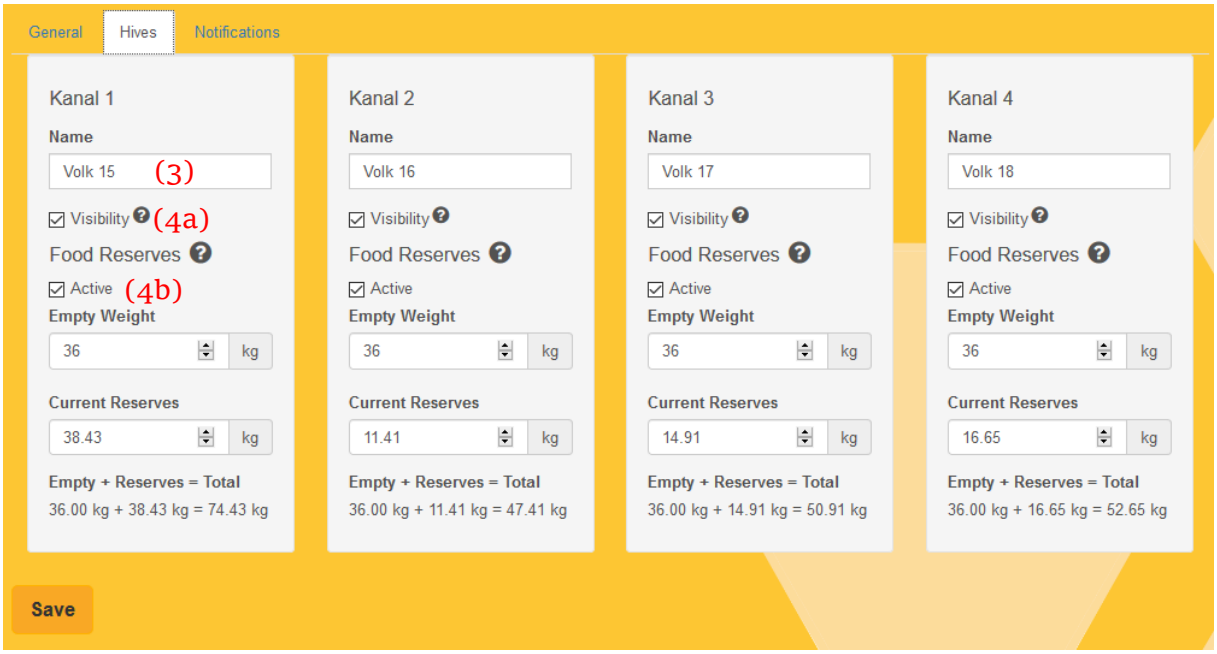
Under the Hives tab, each hive scale can be assigned a name (3) and its visibility configured (4a) – disabled, for example, if not in use. Hiding unused scales eliminates clutter on the Dashboard and Timeline.

You can also activate the display of remaining food reserves (4b), either by defining an empty hive weight or by setting the current level of food reserves. After clicking on Save, the hive's current food reserves will be shown on the Dashboard. Once the empty hive weight has been established for each scale, a quick overview of the current reserves is always available on the Dashboard, a feature that is especially useful in winter.

The difficulty in setting this up is determining the correct “empty hive” weight, as each hive is different and the weight of the bees and comb must also be taken into consideration. The following possible approaches are recommended:

a. Given existing weight data for the hive from March/April of the previous year, define the lowest value from this period as the empty hive weight, based on the assumption that at this point food reserves were largely exhausted and all other parameters (weight on roof, number of frames, etc.) remain the same.
b. Lacking suitable prior data, try to roughly estimate the current food reserves and enter this value. However, one must be careful that the estimated reserves are not greater than what is actually present.
c. Enter the known weight of the empty hive or weigh it separately. Keep in mind that the weight of the hive scale platform and initial tolerances must also be taken into consideration; the tare weight thus should be determined for each hive scale. This can easily be done by removing the hive for two minutes, noting the empty weight on the Timeline, and then adding this value to the known empty weight.

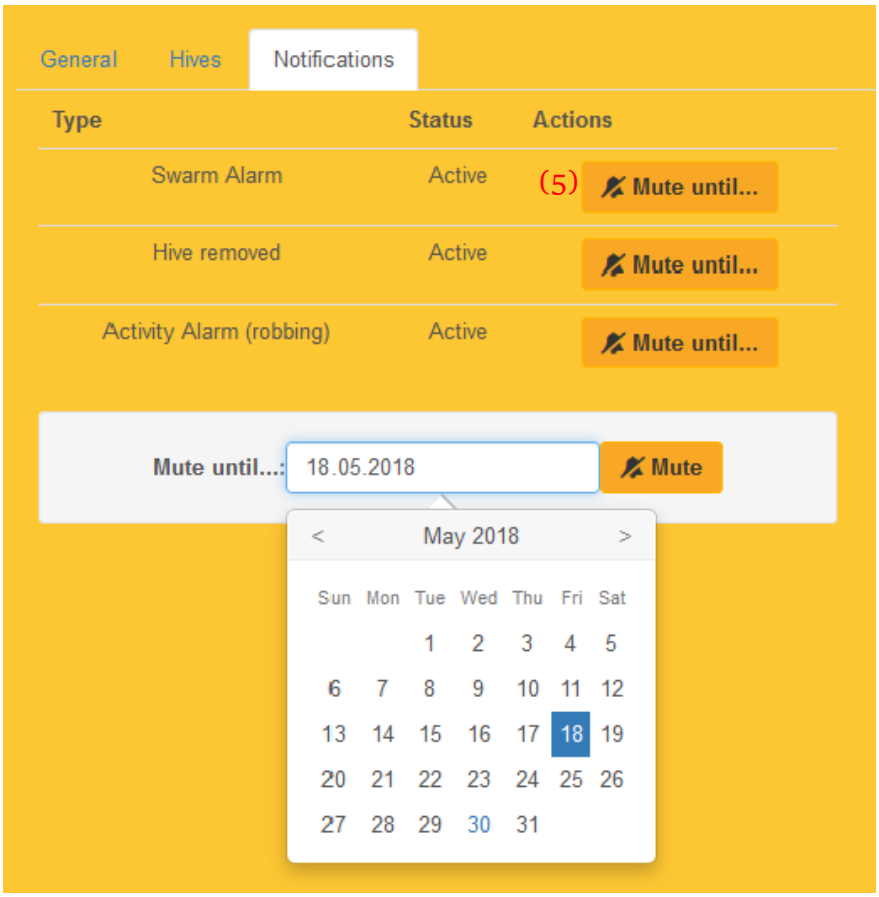
In any case, it is best to gain your own experience over the course of the next winter to determine the best strategy. Ultimately, the goal is not to measure food reserves to the last gram, but to get an early warning when reserves become scarce. At that point, it is then up to the beekeeper to clarify the situation on site and feed if necessary.



Notifications

Under Notifications you can deactivate all alarms for a configurable period of time. This especially makes sense for the swarm alarm, which can be deactivated after the swarm season has ended. This prevents false alarms when working the hives outside the swarm season.

In the example below, the swarm alarm has been disabled until August 1, 2019. Of course, it is possible at any time to manually reactivate the alarm (5).



5 Support

Thank you for choosing a premium-quality product from HiveWatch. Should you have a concern or need assistance, we are available at the following telephone number and e-mail address:

Telephone Support Hotline: +41 (0)32 510 20 47

E-Mail: support@hivewatch.ch