HEART RATE TRAINING ZONES

Zone	Borg Scale	Bpm[1]	% of Max HR	Zone Definition	Exercise Intensity	Physical Exertion
1 Recovery	6			Recovery Zone	Very, very light (at rest)	How you feel when lying in bed, watching TV, or relaxing in a comfy chair. Little or no effort.
	7					
	8					
	9			Easy	Very Light	
	10					
	11		<60	(Fat Burning)	Fairly Light	
2 Endurance	12			Aerobic		Feel like you can exercise for hours. Easy to speak and breathe.
	13		<70		Somewhat Hard	
3 Stamina	14			Steady State (LTHR)		Feels energetic to exercise for hours. Can carry on brief conversation.
	15		<80		Hard	
4 Economy	16			Anaerobic		Discomfort, very difficult to maintain exercise intensity and breathe
	17		<90		Very Hard	
5 Speed	18			VO_2 Maximal		Feels almost impossible to keep exercising. Feel completely out of breath.
	19				Very, Very Hard	
	20		<100		Exhaustion	

[1] Kavonen modified - This zone set uses the Kavonen method for setting zones, however it allows for the use of a measured max heart rate vs. the assumed formula originally specified in Kavonen for more personalized accuracy.

Heart-rate measurement can be a black art; there is no doubt about it. There are many different ways of measuring heart rate, each with its own benefits and drawbacks. I'll go through a couple of ideas in this article that should help you calculate your heart-rate training zones with some degree of accuracy and explain how heart rate training works.

But first..why do we bother measuring and using heart rate? It's effectively a way of looking at the effort we're making so we know how hard we're working and, ultimately, how hard we can work. Use of heart rate training zones lets us make efficient use of our training time and gives us a measure of improvement. We generally split training zones by looking at percentage heart rates based on maximum heart rate alone, or maximum and minimum heart rates. The information above shows the convention of heart rate zones, the uses of that particular zone, and the percentage heart rates used to bracket these zones (we'll go into heart rate zone calculation with real numbers later).

The percentages I've used here aren't necessarily the ones you'll see in every book—some coaches use different percentages.

However, heart rate measurement is not ideal when used on its own and we should be aware that there are other methods of measuring effort:

Borg Scale of Rate of Perceived Effort (RPE)

The Borg Scale of RPE is a scale between 1 and 20, with 1 being no effort at all and 20 being all-out, lung-popping, maximum effort. It's a perceived scale, developed by Star Trek Generations fans, and is highly subjective as it's up to you to decide how hard you're working, rather than use a scientific method of measurement to tell you. It can, however, be very useful in conjunction with heart rate monitors. For example, you're out on a run and you feel like you're working really hard - say, a '15' on the perceived exertion scale; however, a quick look at your heart rate indicates that you're only working in your 60-65% recovery zone. Something isn't right - the conflicting signs show that you're probably over-trained. The use of a subjective method (rate of perceived exertion), along with an objective and more scientific method (heart rate or power) means we have a good way of estimating our work rate and also spotting over-training and illness.

As you can see, this is really wishy-washy ('somewhat hard''?!?) and cannot be recommended for use on its own. It's a very personal system so you have to remember things for yourself and don't use other people's 'effort'.

VO_2 Max

Steve Trew defines VO_2 Max: "At a particular work intensity, the oxygen uptake of each individual will reach a plateau - the maximal oxygen uptake or 'VO_2 Max'. If the triathlete exercises at a greater intensity, the oxygen uptake will not increase, because the body is now taking in and using all the oxygen it can". The VO_2 Max value is often divided by body weight in kilograms and then expressed as millilitres of oxygen used per kilogram of bodyweight per minute, or ml/kg/min. As with heart rate, we can define percentages of VO_2 Max for training zones. The problems with using VO_2 Max include: you need a gas analyzer to measure it (found in laboratory, not your garage); different athletes may have very different VO_2 Max values for the same performance level, and vice versa; VO_2 Max is limited by genetics, etc. All in all, one for the boffins - by all means read up on it, but it won't be of much use to us.

Power

Power is an excellent method of measuring exercise effort/intensity and is the current ‘hot training method’ with professional cyclists in particular. It is normally measured in Watts and, like heart rate and VO_2 Max, percentages of maximum output power can be used to define training

zones. Power measurement is immediate and doesn’t have the delays associated with heart rate (heart rate does not respond instantly to effort). It’s only really on the bike that we can measure power accurately as there is a conversion of our body’s energy to mechanical energy; unfortunately, this means that that training with power is limited to the bike. It is, however, easier to measure than VO_2 Max but equipment is still expensive (£400 minimum), especially if you want to be accurate. Because of price, it still isn’t accessible to the average triathlete and so I won’t go into it much here. If you want to learn more, have a read of ‘Going Long’ by Joe Friel and Gordo Byrn.

Calculating Training Zones Using Heart Rate

Heart rate is - as it suggests - a measurement of the number of times our heart beats in a minute, hence the measurement is in ‘beats per minute’ or ’bpm’ - clever, eh? Our muscles need blood and oxygen to work and when we exercise they need more, so our heart beats faster to pump more blood and oxygen round the body. So, the rate at which the heart beats should give a great indication of how hard we are working - right? Well, pretty much. There are a number of environmental/physiological conditions that affect heart rate, like temperature, altitude, dehydration, physical well-being (illness), injury and fatigue, etc. For example, you get up one morning, check your heart rate, and find its 5-10 bpm higher than it normally is - you might feel fine at the time but it’s likely that your body is fighting off infection (pumping nutrients, white blood cells, protein, etc. round the body to fight infection and repair damage) and you’re likely to feel a cold or something coming on soon. So we need to be aware of these possible problems and this is where other methods like ‘rate of perceived exertion’ can complement heart rate.

So, how do we use our heart rate to calculate training zones that we can apply practically to our training programmes? Convention says that we need to know 2 values: the maximum heart rate and resting heart rate.

Maximum Heart Rate

As it suggests, this is the highest bpm we can manage without dying. It sounds quite melodramatic but measuring maximum heart rate is actually quite a stressful thing to do and you have to make sure you are well rested and uninjured before you attempt it. The simplest (and probably most inaccurate method) is to use the formula ‘220 - your age = max heart rate’.

For me, at a sprightly age of 32, it would be ‘220 - 32 = 188 bpm’.

So how does that compare with a more scientifically measured max heart rate? Actually, my maximum is 194 bpm - which isn’t that far off but is still too inaccurate for our purposes. I’ll cover 3 methods of measuring maximum heart rate: one on the bike and 2 on the run - these are all called ‘ramp tests’ as they ramp up from easy to exhaustion.

The bike method uses either a bike on a turbo trainer or an ‘ergometer’ bike thingy (the one where you have a stationary bike set-up with a front flywheel that is braked using a webbing strap around the flywheel circumference). The rider wears a heart-rate monitor, starts with a 10 minute warm-up, then pedals in a low gear (easy) at about 90-100rpm. Every 2 minutes a harder gear (or more resistance) is selected. The rider tries to keep this cadence (pedal speed) up until no longer able to manage it, - i.e. exhaustion - and the heart rate at this point should correspond to the maximum.

Running methods are similar. The first is done on a treadmill (can be done on the track): after a good warm-up, a comfortable pace is found and like the bike test, we then increase the pace every 1-2 minutes until exhaustion. Be careful with this one that you don't fall off the treadmill at the end! An alternative is to find a steep-ish hill that takes about 30 seconds or so to run up. Warm up and then run up the hill quickly 4 times, with a rapid jog back down the hill in between

and no rest at the bottom between each repetition. On the 5th repetition, go as fast as possible and measure heart rate at the top - you should be chin-strapped at this point!

Maximum heart rate is a bit weird: it doesn't change that much throughout adult life. It can change slightly but isn't generally dependent on fitness. We could now just calculate heart rate training zones by taking percentages of maximum heart rate. For example, to calculate our Zone 3 heart rate upper and lower limits, we just take 70% of max heart rate for the lower limit and 80% for the upper limit

(for me , it would be 0.70 x 194 = 136, and 0.80 x 194 = 155).

This, however, doesn't take our resting heart rate into account.

Resting Heart Rate

Right, we now have one half of the data we need, but why is resting heart rate important too? Unlike maximum heart rate, resting heart rate is very dependent upon fitness; generally, the lower the resting heart rate, the more efficient your heart is and the more blood is pumped for each heart beat. As you get fitter, resting heart rate should get lower. So, to make sure your training zones are accurate, measure resting heart rate every couple of months and adjust training zones accordingly.

It is rumoured that cyclist Miguel Indurain had a resting heart rate of something daft like 35 bpm - uh? That's around one heart beat every couple of seconds! It's practically clinically dead.

Resting heart rate is a piece of the proverbial to measure. Over a week, measure your heart rate every morning before you get out of bed. The average of your measurements that week is your resting heart rate. Make sure you don't have a cold or anything as this will raise your resting heart rate artificially.

Training Zone Calculation

We can now calculate the heart rate dynamic range (range over which heart rate changes) and the training zones. This particular method is called the 'Karvonen Method', after the guy who invented it, Dr Method. Not really - that was a joke.

Heart rate dynamic range is simple:

'Max Heart Rate - Minimum Heart Rate = Dynamic Range'

We calculate training zones using a percentage of the dynamic range and then we add the resting heart rate to get the final value:
Value = (Zone Limit % x Dynamic Range) + Resting Heart Rate. See? It's pretty easy, really.

Lactic Threshold

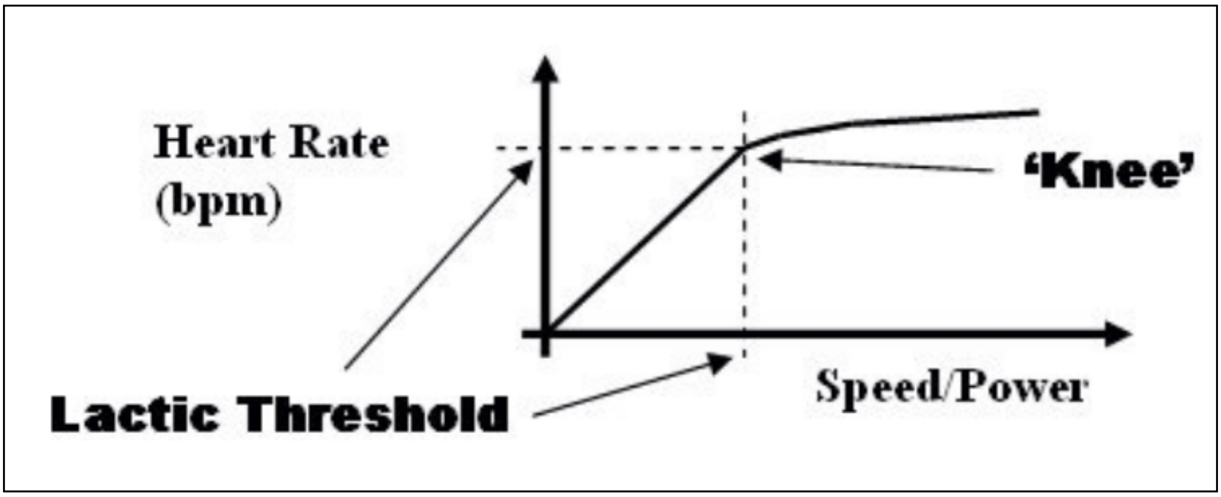
Lactic acid is a waste product that is produced in the muscles during exercise. The problem is that as we increase exercise intensity, the amount of lactic acid produced increases too; below the lactic threshold (also known as the 'anaerobic threshold'), the body is able to flush this waste from our muscles and we retain a balance. We eventually get to a point where the body cannot get rid of the lactic acid fast enough, the balance tips in favour of the lactic acid and we get that burning sensation in the muscles which eventually stop them contracting properly. Lactic threshold is a key limiter for performance but is, luckily, very 'trainable'. Most anaerobic training is designed to raise the lactic threshold so we can exercise at a higher intensity without being limited by lactic acid. Typically, lactic threshold is around 80-85% of heart rate (somewhere between 165 and 173 bpm in the above example calculations) and we need to have an idea of our threshold value so that we can train either slightly above, or slightly below it in specific lactic threshold training sessions.

There are lots of ways of measuring lactic threshold and I'll briefly mention 2 methods here:

1. Conconi Test

In the laboratory, lactic acid is measured using blood tests. It is unlikely you'll have a lab in the garage but this is the next best thing. The Conconi test uses repeated intervals (running on the track or biking on the turbo trainer) over a set distance (e.g. one lap of the track).

Each lap of the track is run slightly faster than the last i.e. increasing the intensity by, say, one second. The heart rate is measured over the last quarter of the interval and the speed is calculated from the time and distance (both known). You then plot a graph of heart rate against speed and, at the lactic/anaerobic threshold there will be a 'knee' - see diagram. You can do the same by measuring power and plotting power against heart rate. What we get is a speed or power and an associated heart rate for the lactic threshold. As we get fitter, the threshold values of heart rate and speed/power will increase. Therefore, we have to measure progress every few months.



2. Time Trial/Race Method

Easier is the 10 km race test. Wear a heart rate monitor and run a 10 km road race over a fairly flattish course. Use the 'Average heart rate' function on the heart rate monitor and that heart rate will be exactly - or very close to - your lactic threshold. If you don't want to run it, try a 25 mile bike time trial instead; again, take the average heart rate (see below for 'sports specificity' factor). Check the value against the calculations you've made above - if it's miles off, something's wrong. Give it a couple of weeks and then do it again.

Heart Rate - Sport Specificity Factor

There's one slight problem we've not discussed yet, and it can have a significant impact on your training. Heart-rate changes with loading and intensity, but loading and intensity also depend on which sport you're doing.

The Karvonen method I mentioned before is most accurate for running heart-rate training zones and running is probably the most intense sport, as you have to fully support your own bodyweight on your legs and fight gravity as well as propel yourself forward. In cycling, unlike running, your bodyweight is mostly supported by the bike and you also have the option to freewheel, effectively having a rest for a bit, which you can't do in running. In swimming, the whole body is supported by the water and, remember, you don't have to swim uphill against gravity! This means that your lactic threshold for running - particularly if you come from a running background - will be higher than it will be for cycling, and even higher than for swimming. If you don't believe me, try the 10 km running and 25 mile bike time trial methods of estimating lactic threshold.

The threshold value for cycling will be around 5-10 bpm lower than for running. There is an easy solution, though: calculate Karvonen values for running and then subtract approx 10 bpm to get heart-rate zones for cycling and about 15 bpm for swimming.

This should be good enough to be getting on with but, as you get more experience, you can adjust values to make sure you are in the correct zones for each sport. It's also a good reason to get used to the scale of perceived exertion I spoke about earlier: you can compare your own subjective feeling of RPE with the heart-rates you are achieving and see if they match up between sports.

Summary

The problem with heart rate monitoring is that, while the basics are dead simple, there are loads of other little things you need to be aware of to get the best out of your heart rate monitor and your training. Start with the basics and add the rest as you get comfortable with the ideas. It is worth it and is the best training method for those of us who cannot afford to spend wads of cash on gas analysers and power meters.

It may also be a good time to get yourself a book on the subject which goes into more detail and may explain things in a different way which is easier for you to understand - I've put some good reads at the end of the article.

The choice is yours…

Books to Read

'Serious Training for Endurance Athletes', Rob Sleamaker & Ray Browning, ISBN: 0-87322-644-5
'Triathlon: A Training Manual', Steve Trew, ISBN: 1-86126-386-4
'The Complete Guide to Triathlon Training', Hermann Aschwer, ISBN: 3-89124-515-7
'Going Long - Training for long-distance Triathlons', Joe Friel & Gordon Byrn, ISBN:1-932382-24-7
'The Triathlete's Training Bible', Joe Friel, ISBN:1-884737-48-X