

PART ONE

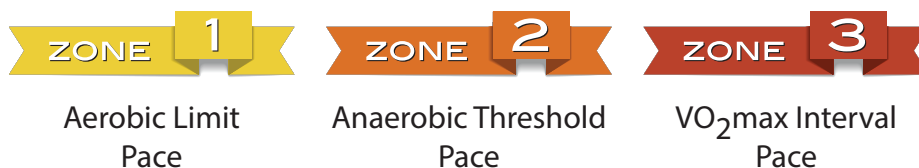


Endurance Athlete Training Zones for Long-Distance Competition

Properly quantifying an endurance athlete's training zones or "gears" when preparing for a marathon or similar long-distance event requires specific procedures and calculations. Interestingly, many methods for training elite endurance sport athletes are based on empirical evidence and routines shared among athletes. There is a comparative lack of published peer-reviewed literature on the subject as research relies on the stringency of the scientific method; which often creates limitations to real-world applications for coaching and conditioning. For example, research often emphasizes $VO_2\text{max}$ values when examining improvements in aerobic capacity, but many coaches prefer monitoring progress using heart rates (HR) or movement speeds for simplicity. The following information relies on strategies applied by successful coaches with progressively improved race times functioning as the supporting evidence for improved endurance event performance.

Discerning appropriate training zones among endurance athletes is more intricate than simply using the fitness formulas common to healthy adults in the general population. The physiological aspects most associated with success during endurance performance include the athlete's aerobic capacity, anaerobic threshold and movement economy. Since VO_2max in itself is not a primary predictor of success (except among lower-level athletes exhibiting broad ranges 15-20 ml/kg/min), it is the relative percentage of VO_2max an athlete can sustain, or highest tolerable speed that matters most among the competitive elite. Athletes with VO_2max values ranging from 45-60 ml/kg/min can all run a 6:00-mile pace which indicates movement economy will significantly impact the race outcome. In any case, training must include stressors that elicit improvements in each area. The training zones in the following figure and covered in this article have been found to improve each relevant variable and promote success when properly used to prepare for a long-distance race.

Key training zones to be identified when preparing for a marathon or other long-distance event:



In the following analysis of each training zone, percentages of the athlete's VO_2max or heart rate max (HRmax) as well as rate of perceived exertion (RPE) using the Borg scale are used. In order to apply percentages one must first calculate or estimate the maximal value or capacity. For HRmax (often preferred) and VO_2max , a coach can obtain a direct measure using an appropriate cardiovascular fitness test, such as the Astrand test. Otherwise, an athlete or coach can simply add 5 beats to the highest HR previously reached during a competitive event for a HRmax, or multiply a known 5K pace

by 0.985 for a VO_2max pace.

Remember, outside of the laboratory setting many training values are actually educated estimates. The Borg scale includes subjective values of perceived exertion and is therefore a great predictor of fatigue - which is largely psychological in nature as exercise tolerance is very difficult to quantify. RPE is preferred among athletes on medications that impact HR values or in situations where no HR monitors or measurements are desired. The scale runs from 6-20, which by adding a zero, loosely reflects HR per minute.

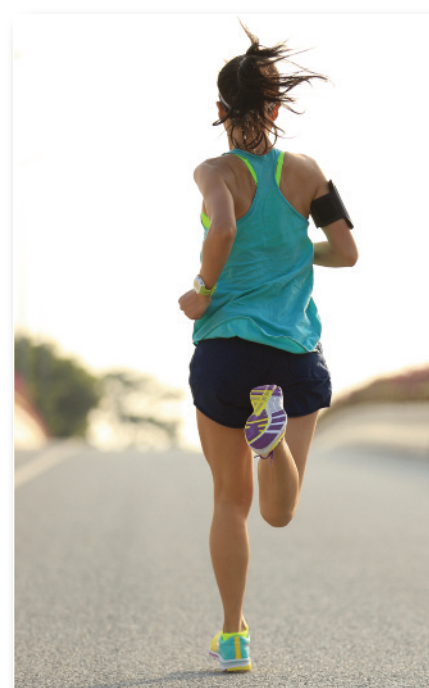
ZONE 1

TRAINING

The aerobic limit is essentially a metabolic junction where fat use peaks just before glycogen becomes the predominant fuel source. This junction, often called FATmax is reached at about 65% VO_2max , 80% of HRmax, or a value of 14 if using RPE monitoring. Crossing this point means lactate production begins to exceed muscular disposal rates, but not total-body rate, so the athlete will feel very mild discomfort. Lactate actually functions in the process of clearance as it will be used by the heart, kidneys, brain and other aerobic cells allowing breathing to remain relatively relaxed as systemic acidosis will not occur. Zone 1 training represents long slow distance (LSD) training or recovery runs used in between Zone 2 or 3 sessions. It is often the bulk of an endurance ath-

lete's regimen at the beginning of a program to develop a conditioning base that promotes glycogen sparing and slow twitch fiber hypertrophy.

For many athletes, training in this zone will feel too easy but will obtain numerous benefits - coaches will often need to instruct the athlete to slow down. Zone 1 training allows for improved postural endurance, movement economy, hypertrophy and vascularization of slow-twitch fibers, fat oxidation for glycogen preservation, and asynchronized motor unit firing patterns to greatly preserve energy. Due to the slower speed it should be understood that postural adjustments may increase the need for peripheral muscular endurance. Many will find this pace about 1:00-1:30 min/mile slower than their marathon or race pace.



On average, elite marathon runners spend about 80% of their training time in this zone to reach their necessary mileage per week while sparing adequate glycogen. However, excess aerobic limit training can reduce the athlete's power, maximal speed, and fat-free mass as well increase the risk for endocrine disruptions or skeletal imbalances. In addition to the physiological measures listed previously, the steps shown in the figure can also be used to refine the calculation of an aerobic limit heart rate based on personalized factors.

Steps to calculate an aerobic limit HR:

Subtract the athlete's age from 180 (180 - age)

Recovering from a major illness, disease, operation or taking a regular medication = **subtract 10 bpm**

Novice, deconditioned due to injury, or high susceptibility to upper respiratory tract infections/allergies = **subtract 5 bpm**

Trained at least 4x/week without injury for up to 2 years, does not suffer from colds more than 2x/year = **no value change**

Trained for >2 years without any injury and has been making progress in the program = **add 5 bpm**

ZONE

2

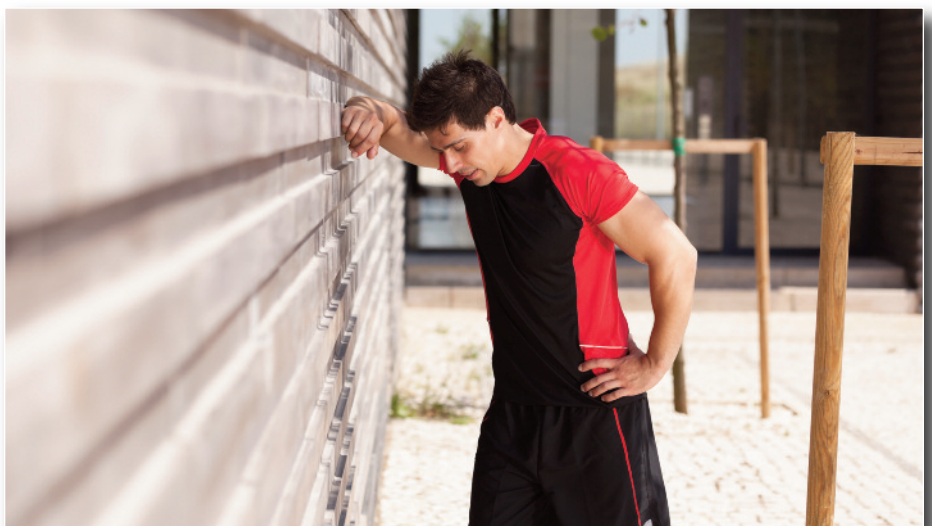
TRAINING

Anaerobic threshold represents a work rate that is high enough to promote total-body lactate/hydrogen ion accumulation and systemic acidity. It is essentially another metabolic shift where aerobic metabolism must be supplemented with anaerobic energy, as the steady-state condition is lost. This usually occurs at about 85% of VO_2max , 92% of HRmax or an RPE value of 17. These values can vary based on the athlete's buffering capacity and previous training. As ventilatory threshold is reached at this higher work intensity it becomes difficult for the athlete to "catch their breath." This supports why the talk test is often used to estimate if an athlete is crossing their anaerobic threshold - if an athlete can hear their own breathing and finds it difficult to articulate full sentences they have reached anaerobic threshold. In any case, increasing acidosis due to systemic lactate and hydrogen ion accumulation ultimately forces the athlete to stop or slow down. The culmination of high HR, ventilation rate, type II fiber recruitment, respiratory muscle oxygen demand, and glycogen use surpass a critical point. Better conditioned athletes can sustain this workload for a while but will ultimately hit a

point where systemic acidity prevails.

Zone 2 training is integral as most endurance events require significant anaerobic support; especially during the final sprint at the end of a race. A higher anaerobic threshold equals higher tolerable speeds during the entire event. Zone 2 training sessions include tempo runs and short intervals lasting 30-120 seconds interspersed with bouts of lower-intensity jogging or complete recovery using a 3:1 work-rest ratio. The length and duration of tempo runs can vary between 1-2 miles to upwards of an hour working at a

pace similar to race pace. It is recommended to not exceed 60 minutes of Zone 2 training each week, which will equate to about 10% of total training volume (including recovery intervals). Excess work at this intensity can easily promote non-functional overreaching or overtraining, severely deplete glycogen, and reduce the ability to use fat as a fuel. Benefits of appropriate Zone 2 training can include increased power output, fatigue resistance among type II fibers, caloric expenditure, and exercise tolerance via a reduced sensitivity to acidosis.



ZONE

3

TRAINING

Zone 3 training includes short bouts of work at very high intensities. The VO_2max interval pace is roughly equal to the speed an athlete can maintain for 1.5-2.0 miles, or 3,000 meters. Training status, sport-specificity and other variables will cause some variance between athletes but this pace can normally be sustained for 5-10 minutes. If using HRs to estimate Zone 3 session intensities, the athlete should be about 5 bpm below their measured HRmax during work intervals. To determine the intensity using movement speeds, take the athlete's VO_2max pace and divide it by 1.12 (Example: 6:00 mile pace \div 1.12 = 5:36 mile pace). The VO_2max pace is best determined by having the athlete perform a maximal-effort 3,000-m time trial (as alluded to previously) as this is the maximal length an elite athlete can cover while at their VO_2max .

Usually, Zone 3 training includes 5-10 minute bouts of work at or slightly above VO_2max interspersed with full, passive recovery periods. Intervals can be performed up to about 125% of VO_2max for 2-5 minutes using a 1:1 work-rest ratio. For example, a runner performing a 1600-m run in six minutes on the track at 110% of

their VO_2max pace would then recover for six minutes before performing their next 1600-m effort. The physiological stress of Zone 3 training warrants that it is limited to about 8% of the total training volume, and is generally not recommended for use until Zone 2 work has been performed for at least four weeks for proper acclimation. Considering the recovery periods used are passive, they are not included in the estimation of training volume.

When applied appropriately, many important benefits are obtained with

training at or above one's VO_2max . These can include an increase in stroke volume, blood plasma volume, oxygen transport efficiency, buffering capabilities, and fatigue resistance among fast-twitch muscle fibers, as well as a reduction in muscle respiratory work to spare oxygen for peripheral musculature. Training in this zone will accelerate the rate by which the athlete's cardiovascular fitness improves, but if performed too early in the program he or she may peak prematurely before the race.



MARATHON PACE



There is one final pace or zone used among elite athletes that it is not categorically considered one of the three primary training gears but is necessary for competing in events >10 miles; a marathon pace. Marathon pace work is generally performed at about 80-85% of VO_2max or 88% of HRmax. Although elite marathon runners spend most of their training in Zone 1, it is important that they perform some work at actual race pace to optimize muscle recruitment and

movement economy specific to the event (event specificity). A perilous flaw would be training to run 26.2 miles (or even a half marathon) without ever working at the actual racing pace. Most coaches understand that marathon runners should progress their LSD or Zone 1 runs to 18-22 miles, and perform 4-6 runs of that distance before the competitive event. However, another important goal should be to perform 2-4 runs of 12-16 miles, at the desired marathon pace.

The following table summarizes the physiological indicators associated with the three primary training zones discussed. Applying these training zones within an appropriate periodized program and applicable adjunct work will be addressed in a later article as the scope would open up to a level of discussion unfit for a single reading. It should also be understood that suitable nutrient intake, rehydration and sleep are just as important as the training itself.

| | Zone 1 Aerobic Limit Pace | Zone 2 Anaerobic Threshold Pace | Zone 3 VO ₂ max Interval Pace |
|------------------------------|---|---|---|
| RPE Values | 14 | 17 | 18-20 |
| %VO₂max | 65% | 85% | >85% |
| %HRmax | 80% | 92% | 95-100% |
| Ventilatory Responses | Increase in ventilation but still barely noticeable | Another increase makes prolonged speech difficult (talk test) | Individual cannot speak due to ventilation rate |

CEU Quiz

Endurance Athlete Training Zones for Long-Distance Competition Part 1

The CEU Quiz is now available online at:

<http://www.ncsf.org/continueded/onlineceu.aspx>

